United States Court of Appeals
for the
District of Columbia Circuit

TRANSCRIPT OF RECORD

BRIEF AND APPENDIX FOR APPELLANT

IN THE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA

Appeal No. 8585

577

THE GRISCOM RUSSELL COMPANY
Appellant,

vs.

CONWAY P. COE, Commissioner of Patents,
Appellee.

Appeal From The District Court Of The United States For The District Of Columbia

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INDEX

Brief For Appellant

PAGE
Jurisdictional Statement 1
Statement Of The Case 2
    The Applicant's Structure 6
    The Novel Features Of The Applicant's Structure 9
    The Decision Of The Lower Court 13
Statement Of Points 13
Summary Of Argument 14
Argument 15
    Point I 15
    Point II 19
The Rejected Claims 21
Conclusion 22

CASES CITED

In re Buchanan, 46 App. D. C. 517 19

Electrons v. Coe, 69 App. 181 19
In re Eastwood, 33 App. D. C. 291 21
Ex Parte Gee, 261 O. G. 850 21

Hirschy Co. v. Wisconsin-Minnesota etc. Co., 18 F. (2d) 347 20

H. Ward Leonard, Inc. v. Maxwell Motor Sales Corp., 252 Fed. 584 20

Imhaeuser v. Buerk, 101 U. S. 647 20

Otto v. Robertson, 62 App. D. C. 233 21
Ottumwa Box Car Loader Co. v. Christy Box Car Loader Co., 215 Fed. 362 20

Thornton v. Coe, 69 App. D. C. 383 19
Topliff v. Topliff, 145 U. S. 156 21

INDEX TO APPELLANT'S APPENDIX

PAGE
Complaint 1
Answer 7
Opinion Of The District Court 9
Findings Of Fact 12
Final Judgment 14
Testimony Of Kenneth B. Ris 15
Examiner's Statement 36
Decision Of The Board Of Appeals 40
Exhibit 1A 43
Prior U. S. Patents:
    Wright, 1,435,364 44
    Jones, 1,617,119 47
    Wilson, 1,737,347 55
    Price et al., 1,842,945 61
    Brown, 1,856,618 67
    Sieder, 2,018,037 75

IN THE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA

No. 8585

THE GRISCOM RUSSELL COMPANY

Appellant

v.

CONWAY P. COE, Commissioner of Patents

Appellee

BRIEF FOR APPELLANT

Jurisdictional Statement

The appellant filed its complaint in the District Court of the District of Columbia under Section 4915, R. S. (35 U. S. C., Sec. 63) against the appellee Conway P. Coe, as Commissioner of Patents, to obtain a decree that the appellant was entitled, as the assignee of Kenneth B. Ris, to have a patent issued to it on the application of Kenneth B. Ris, Serial No. 300,907, filed October 24, 1939 (Appellant's App. 1). Appellee's answer (Appellant's App. 7) contended that the claims for which appellant seeks a patent were unpatentable in view of the prior art as exemplified in certain prior U. S. patents recited in the answer.

The Court below (Justice Luhring) after hearing the witness for appellant entered a final decree on June 21, 1943 dismissing the complaint (Appellant's App. 14). An opinion was rendered by the Court below (Appellant's App. 9) and findings and conclusions drafted by the solicitor for the Patent Office were entered by the Court (Appellant's App. 12).

Appellant filed its notice of appeal to this Court on July 9, 1943. This Court has jurisdiction of this appeal under the act of February 9, 1893, c. 74, 27 Stat. 435, as amended and as incorporated in the District of Columbia Code, 1940 Edition, Title 17, Sec. 101.

Statement Of The Case

The Ris invention for which the appellant seeks a patent is an improvement in that class of apparatus known as heat exchangers. The expression "heat exchanger" includes within the scope of its definition a great variety of apparatus such as boilers, evaporators, condensers and the like, wherein an exchange of heat is effected from one fluid, either gaseous or liquid, to another. For example, in a boiler heat is transferred through the walls of the boiler tubes from the hot flue gases to the water to be boiled. Likewise in a condenser heat is exchanged through the walls of the condenser tubes from the hot steam in the tubes to the cold water circulated over the tubes. Boilers and condensers, notwithstanding the fact that they are both heat exchangers, belong to separate and distinct arts both highly developed and both containing many patents on many improvements which have brought both boilers and condensers to their present high degree of efficiency.

A boiler, theoretically might be used as a condenser and a condenser as a boiler, but practically boilers and condensers are separate arts. The same is true of evaporators, distilling apparatus and other forms of apparatus involving the basic principle of the exchange of heat through the walls of a tube from one fluid, either liquid or gaseous, circulating around the tubes to another fluid which also may be liquid or gaseous, circulated through the tubes. The improvements which render the apparatus particularly efficient in one field may render it useless for another purpose.

The term "heat exchanger" also has a specific meaning in the arts. In a boiler the primary purpose is the generation of steam. In a condenser the primary purpose is the condensation of steam into water, while in the class of apparatus known *specifically* as heat exchangers, the primary purpose is to effect a change in temperature in a circulated fluid, either liquid or gaseous, by a transfer of heat to or from another fluid circulated in heat-conducting relation with it. Heat exchangers are used chiefly in carrying out industrial processes such, for example, as oil cracking, and the heat exchanger of the application here involved was primarily designed for use in an oil cracking process wherein heat must be extracted from oil vapors circulated at high temperatures and under high pressures. It is a "shell and tube" heat exchanger with the vapors circulating continuously through the tubes and the fluid for absorbing the heat in the shell.

For high pressure fluids small tubes must be employed, for it is only in a tube of small diameter that high fluid pressures can be safely carried without making the walls of the tube of a greater thickness than is practical. Small tubes present no difficulties in the handling of clean fluids under moderate pressures, but, as will be obvious, a large number of small tubes is required for the same capacity as a small number of large tubes thereby necessitating a large number of joints and increasing the liability to leakage, which is also greatly enhanced by the high pressures employed. Leakage in the particular field for which the apparatus is designed is not only undesirable because of the waste, etc., but creates a serious hazard for the reason that any oil vapor which leaks into the space containing the water vapor used for cooling the oil creates an explosive mixture and one of the problems solved by the inventor was to design the apparatus so that all leakage is to the outside into the open air and not into the confined space containing the water vapor.

The small tubes which must be used because of the high pressures involved present another serious difficulty when used with petroleum vapors under the temperatures and pressures required for the cracking process. Such vapors are not fixed gases but at high temperatures and pressures contain solid components in suspension. These solid components are largely tars which tend to deposit on the walls of the tubes and, due to the small bore of the tubes, the flow of the fluid is greatly impeded by even a small reduction in its diameter. Also, this suspended solid matter tends to deposit at those points in the path of the circulation where the velocity or the direction of the stream is altered, which means that any bend in the tube or any change in its cross sectional area which produces a change in velocity at an unaccessible point within the apparatus results in a rapid clogging up of the fluid passages, necessitating a shutdown and dismantling of the apparatus.

In the heat exchanger of the application here involved, the tubes within the apparatus effect no change in the direction or velocity of the flow. Instead, all the bends through which the fluid must pass are by an ingenious arrangement placed without the shell of the apparatus and are designed so that they may be individually and quickly detached for cleaning without shutting down except the particular small portion of the apparatus actually being cleaned.

The apparatus not only overcomes these particular difficulties in the oil cracking process for which it is specifically designed but also effects economies in the utilization of the heat extracted from the oil. To this end the apparatus is designed to utilize the extracted heat for the generation of steam at boiler temperatures and pressures so that it can be employed in operating engines necessary for furnishing power to the pumps and for other purposes incidental to an oil cracking process. In the oil fields the water is not well suited for boiler purposes because it contains scale-forming alkalies. Prior to the invention of the application here involved, it was not the custom in heat exchangers to generate steam with the extracted heat from the hot oil, for the reason that scale is produced on the surface of the heat exchanger tubes exposed to the water, thereby reducing the heat transfer efficiency and adding a scale removal problem to the difficulty of maintaining the apparatus in operation. In the apparatus of the application with which we are here concerned the inventor employs a large number of small tubes bowed slightly out of a straight line so that the expansion and contraction of the tubes under the changing temperature conditions will flex the tubes to an extent sufficient to crack off the scale which otherwise would accumulate on the tubes and reduce their heat transfer capacity.

The cracked off scale accumulates in the shell of the heat exchanger and must be periodically removed, the frequency depending on the impurities in the water. To facilitate the cleaning operation the apparatus must be shut down and the tubes removed to give access to the interior of the shell. The handling of a large number of long flexible tubes is a difficult problem but by an ingenious supporting structure the tubes are connected together in a unit which is substantially rigid for handling but which nevertheless is sufficiently extensible to compensate for differences in expansion of the shell and the tubes so that tight joints can be made at each end of the shell without adding stress to the metal.

The inventor, Kenneth B. Ris, is an engineer of long experience in designing heat exchangers and other apparatus in the oil refining industry. The principal reference relied upon is a prior patent taken out by Mr. Ris jointly with one of his fellow engineers (Price and Ris, 1,842,945, Appellant's App. 61). That apparatus represents a prior attempt of Mr. Ris and his associates to perfect an apparatus for extracting heat from petroleum distillate. The structure of the present application is an improvement over the apparatus of the earlier patent. The new apparatus embodies changes over the old apparatus in numerous particulars and Mr. Ris has testified at some length as to the superior performance of the new apparatus. The Patent Office and the lower Court took the position that these various novel features of construction to which the rejected claims are directed are individually and separately old in other apparatus designed and employed for other purposes. The Patent Office has cited no less than five additional patents which they assert show individual features of the combination recited in the rejected claims and they assert that it does not involve invention to modify the applicant's former structure to embody these five separately old features.

It is appellant's position that the Patent Office and the lower Court are in error on both counts, and appellant asserts, (1) the prior art patents do not show the features of construction embodied in the heat exchanger of the application here involved and recited in the rejected claims, and (2) it was patentable invention to combine in a single structure the various elements defined in the rejected claims for the accomplishment of a useful, unitary result.

The Applicant's Structure

That structure comprises the shell 10, referring to Exhibit 1A (Appellant's App. 43) which is a cylindrical drum some twenty-four feet long and four feet in diameter, to which is fed the water to be converted into steam by the heat extracted from the petroleum vapors. This shell is provided with the necessary inlet and outlet passages for delivery of water to the shell and withdrawal of steam therefrom. The ends of the drum are closed by the so-called tube sheets 11 and 13. The tube sheet 13 is slightly smaller than the internal diameter of the shell and is fastened in place by bolts which clamp it tightly against a flange 16 on one end of the shell. A gasket is interposed between the flange and the rim of the tube sheet to make a water-tight joint. The other tube sheet 11 is slightly larger in diameter than the shell and is clamped against the end of the shell by clamping bolts threaded into an external flange 17.

The tube sheets not only close the ends of the shell, but also support the tubes through which the petroleum vapors are circulated. These tubes are marked 12 in the drawing and they extend from tube sheet to tube sheet where their ends are rigidly welded or otherwise permanently attached to holes bored through the tube sheets. The tubes are of comparatively small diameter, for instance, an inch and a half in the commercial setup of the apparatus about which the witness testified, and are bowed. That is to say, the tubes, when detached, are slightly longer than the distance from tube sheet to tube sheet and have a bend or bow representing a departure at the middle of some three or four inches from a direct straight line. Under the extreme temperatures to which the apparatus is subjected, this bow will increase seven or eight inches, representing an elongation of the tube through the heat expansion of the metal of which it is formed.

The tubes are supported at two points in their length on racks marked generally 22, which consist of a series of spaced slats provided with supports 30 (Fig. 3 of Exhibit 1A, Appellant's App. 43) which rest on the bottom of the shell. The two racks are fastened together at top and bottom by angle irons 18, and the whole structure is bolted together to form a rigid support for the tubes, permitting them to "bow" horizontally while supporting their weight against sagging. This rigid structure forming the tube support is slightly less in length than the distance between the tube sheets 11 and 13. It is fixedly bolted to the inside face of the tube sheet 11 but at the tube sheet 13 it is supported by a so-called stud bolt connection (see Fig. 5 of Exhibit 1A) which permits a slight movement of the frame with respect to the tube sheet.

As explained by Mr. Ris (Appellant's App. pp. 17 and 18) this structure permits liquid-tight gasket joints to be made at each end of the shell, notwithstanding the difficulty of building a piece of apparatus twenty-four feet long within manufacturing tolerances of a thousandth of an inch. As Mr. Ris explained, when the tube bundle, consisting of the tube sheets 11 and 13, the tubes 12 and the tube-supporting frame, is removed from the shell, the expansion of the bowed tubes 12 tends to push the tube sheets apart as far as permitted by the stud bolts 32. Now, when the tube bundle is inserted in the shell, from the right to the left as viewed in Fig. 1 of Exhibit 1A, the tube sheet 13 will contact the flange 16 at the left end of the shell before the flange 11 at the right hand end of the shell engages the end of the shell. After the first joint is made tight, the clamping screws in flange 17 at the other end of the shell will be drawn up and in so doing will somewhat increase the bow of the tubes and at the same time shift the tube-supporting frame toward the head 13. Thus the joints at both ends may be drawn tight to just the same extent as if they were entirely independent and not connected by the tube-supporting frame within the shell. If the shells vary in length, as they are apt to do within tolerances of two or three thousandths of an inch the gasket joints will still be tight. The stud bolts need only be long enough to accommodate the extreme manufacturing tolerances permitted.

The Novel Features Of The Applicant's Structure

As stated above, the structure of the heat exchanger here in issue is an improvement on the heat exchanger patented by the applicant here jointly with a fellow employee of the appellant company in the Price and Ris Patent No. 1,842,945. The heat exchanger of that patent was also designed for the oil refining industry, but since its advent some ten years ago the oil cracking processes have been modified. Greater capacity and higher efficiency than were required ten years ago are now demanded, and the apparatus of the application before the Court was produced to meet the new demands. The new apparatus comprises, in common with the old apparatus, an elongated horizontal shell through which the cooling medium is circulated. In the old apparatus water is employed as the cooling medium but the heat extracted is insufficient to generate steam, so no problem of scale removal is presented. In the old apparatus cold water is merely heated to hot water. In the old apparatus as well as the new apparatus a large number of initially bowed tubes of small diameter are used for the circulation of the hot vapors. In the old apparatus these bowed tubes were used to permit expansion of the tubes without rupture, but as no steam is generated there is no scale formation on the outside of the tubes and therefore no necessity for frequent removal of the tube bundle in order to clean out the scale deposit.

In the old apparatus the tube sheets in which the ends of the tubes are supported do not form the end closures of the shell with their outer faces exposed as in the new apparatus, but instead the tube sheets are covered with the conventional headers through which the oil flows in its passage from one bank of tubes to the next. This conventional header structure, while universally employed because the art knew of nothing better, is inherently defective because, in the event of leakage around the tube ends, the leaking oil will seep into the vapor space and create an unwarranted hazard of explosion. In other words, at the high temperatures and pressures for which the apparatus is designed, it is not safe to rely on keeping all the tube joints tight at all times. The inventor therefore devised a novel structure which rendered the leakage innocuous. To this end in the new structure the tube sheets *themselves* (11 and 13, Fig. 1, Exhibit 1A, Appellant's App. 43) form the exposed ends of the shell and the ends of the tubes instead of discharging into a common header are connected by individual detachable U-shaped connections 14. By this arrangement any leakage of steam from the interior of the shell around the ends of the tube is merely discharged into the open air and likewise any leakage of oil through the joint between the U-shaped connections and the interior of the tube also escapes to the outside, thus completely removing the hazard of explosion.

This novel structure is recited in claim 1:

> " . . . said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough."

This novel structure is recited in *all* the rejected claims in appropriate language.

Another and equally important feature of the new heat exchanger is the "tube bundle" structure. In the old apparatus the ends of the tubes are supported in the tube sheets so that the bowed tubes form the principal connections between the tube sheets. In addition there is a baffle structure made up of tie rods and cross bars so as to be flexible and have enough give to permit the expansion and contraction of the tubes without placing undue stress on the metal.

For a heat exchanger having no scale removing problem and which need be taken down only for inspection and repair, the structure of the granted patent was entirely suitable, but, as pointed out by Mr. Ris, the difficulty of removing and replacing a tube bundle some twenty-four feet long with the tubes and baffle supports of the flexible articulated structure of the early patent is difficult and tedious, and the labor, plus the loss from a long period of shutdown each time the shell had to be opened for scale removal would entirely offset the advantages and economies resulting from the saving in steam. On the other hand, if the tube sheets are rigidly connected by structural members such as common in apparatus designed for moderate temperatures, it is impossible to secure tight joints at both tube sheets (Appellant's App. 18).

To remedy this difficulty the inventor devised a *rigid* supporting and connecting structure for the tube bundle and attached it *rigidly* to one of the tube sheets. At the other end, however, the frame structure is not rigidly bolted to the tube sheets, but instead is carried by stud bolts 27 (Fig. 5, Exhibit 1A, Appellant's App. 43), which are long enough to permit a *slight* longitudinal movement of the tube sheet relative to the frame. This play between the tube sheet and the frame does not significantly detract from the rigidity of the tube bundle as a whole. The bowed tubes are formed of straight tube sections which in the fabrication of the apparatus are bowed by pressure exerted on their ends so that in the assembled tube bundle with its numerous tubes, the tendency of the tubes to straighten holds the end pieces of the frame firmly against the heads of the stud bolts, so that in the withdrawal and replacement of the tube bundle it is to all intents and purposes a rigid structure. When the tube bundle, however, is placed in the shell with the inner tube sheet 13 seated against the inturned flange 16 at the left end of the shell as shown in Exhibit 1A, the opposite tube sheet 11 will not quite come in contact with the out-turned flange 17 at the opposite end of the shell, but when the clamping bolts, between the tube sheet 11 and flange 17 are drawn tight the heads of the stud bolts 27 will be separated from the ends of the frame structure to whatever extent is necessary to place the desired compression on the gasket. Thus a tight joint may readily be formed at each end of the shell, which would be difficult, if not impossible, with a rigid tube supporting structure.

This lost motion connection between one tube sheet and the rigid tube supporting structure also serves a second essential purpose, namely of taking up any inequalities in expansion of the shell and the tube-supporting structure. In an apparatus where water is employed as the cooling medium the temperature difference between the shell and tube bundle structure will not be significant. The shell and the tube-supporting structure will both have a temperature approximating that of the water. With the generation of steam at boiler temperatures and pressures, however, there may be a considerable difference in temperatures between the frame structure which is entirely enclosed with steam space and the shell wall which is in heat-radiating contact with the outside air. This stud bolt structure permits any differential expansion between the frame structure and the shell that may occur, without placing the metal of either part under stress.

This novel stud bolt structure is also specifically recited in the claims, for example, in claim 1, as follows:

> " . . . spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes."

In the other rejected claims these principal novel features viz: the exposed tube sheets, the wholly external, removable pipe connections, and the substantially rigid—yet slightly extensible—tube supporting structure are recited in more specific terms, than in claim 1. In addition, other novel features are included in certain of the claims which will be more specifically discussed under the heading "The Rejected Claims."

The Decision Of The Lower Court

The judgment of the lower Court (Appellant's App. 14) affirmed the finding of the Patent Office that the appealed claims were not patentable over the prior art. The Court below rendered a brief opinion (Appellant's App. 9) wherein it simply stated that all the features of the applicant's structure "were adapted for the specific purpose for which they were used in the prior art" (Appellant's App. 10, l. 20). The Court then held that merely bringing these various devices together was not an act of invention. The Court in its opinion makes no attempt to point out wherein the various devices *are* disclosed in the prior art. In fact in the opinion there is no discussion of the prior art whatsoever. The Findings of Fact prepared by the solicitor for the Patent Office and entered by the Court (Appellant's App. 12), while containing a brief statement of the structure disclosed in the cited patents, likewise makes no attempt to point out in any of the cited patents the particular elements recited in the rejected claims.

Statement Of Points

It is applicant's position that the lower Court was in error in its finding that the elements of applicant's heat exchanger "were adapted for the specific purpose for which they were used in the prior art". That on the contrary there is no disclosure in the cited art of the features recited in the rejected claims which the witness asserted to be novel.

The lower Court was also clearly in error in holding that it "was not an act of invention" to combine these various devices in a unitary useful structure, even assuming that such devices were individually old in the prior art.

SUMMARY OF ARGUMENT

Point I

The claims define not only novel combinations, but also combinations of novel elements. These novel elements, in the language of claim 1 are:

> 1. Spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and tubes;
>
> 2. Tube sheets constituting the exposed end walls of said shell; and
>
> 3. Removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes, etc."

The Brown patent (Appellant's App. 67) relied upon by the Patent Office for a disclosure of the first of the above enumerated novel elements discloses no connection whatsoever between the tube sheets save the tubes themselves and the side walls of the casing or shell. The third connection between the tube sheets of applicant's structure, viz., *the spacing means,* is totally lacking.

The Wilson patent (Appellant's App. 55) relied upon as a disclosure of the other two above enumerated elements contains neither tube nor tube sheet, but is a solid block of metal with bored passages for the flow of fluid.

Point II

The claims are patentable whether or not the individual elements are *per se* old. The witness testified that the apparatus of the application here in suit served a new and useful purpose not obtainable with any apparatus of the prior art. The Patent Office and the lower Court attempt to build up an anticipation by a minimum of three patents for claim 1 and as many as six patents for the more specific claims. This is contrary to the uniform decisions of this Court.

ARGUMENT

Point I

The claims define not only novel combinations, but also combinations of novel elements.

As stated above, claim 1, which is the broadest claim, recites at least three novel elements which are disclosed neither individually nor in combination in the cited art. The first such novel element is the "tube sheets constituting the exposed end walls of the shell". Of the six cited patents, five show heat exchangers (in the broad sense that an evaporator may be a heat exchanger) embodying tubes and tube sheets, and in every one of these five patents the tube sheets are covered with the conventional headers in which, in the operation of the apparatus, the body of the fluid to be cooled is separated from the cooling fluid only by the tube sheet itself whereby any leakage from one side to the other of the tube sheet will result in a mixture of the fluids, which mixture in the oil refining industry would be an explosive mixture.

The sixth citation, Wilson 1,737,347 (Appellant's App. 55), discloses no tube sheets at all. The Wilson structure is a solid block of metal through which a series of holes are bored for the passage of fluids. There is no shell containing a body of liquid surrounding a series of heat exchanger tubes. The heat exchange is effected solely by conduction through the solid metal of the block, and there is consequently no leakage problem to contend with.

Neither the lower Court in its opinion or findings, nor the Patent Office in its decision attempts to point out any structure comprising tube sheets forming the exposed ends of the shell.

The second novel element recited in the claims, again quoting from the language of claim 1, comprises the "removable fluid passage supported *on said tube sheets* exterior to the shell connecting said tubes", etc. (emphasis ours). The Patent Office contends that this feature is anticipated by the Wilson patent. The sole mention of the Wilson patent by the lower Court is in the Findings of Fact, as follows:

> "5. The patent to Wilson, No. 1,737,347, shows a heat exchanger comprising a block of metal having fluid passages therein, and connections between different passages on the outside of the block."

This is a correct statement of the entire disclosuse of the Wilson patent, and this very statement *excludes both tubes and tube sheets.* It would seem obviously impossible to connect passages through a solid block by anything but connections "outside of the block". As Wilson employed neither tube nor tube sheets, he had no problem of leakage around the tube from one side to the other of the tube sheet, and consequently as his structure presented no problem even remotely related to that solved by the applicant's structure, it cannot be said that his patent in any way contributed to the solution of that problem. Pipe connections in the form of U-bend's are *per se* old and are used by plumbers and steamfitters wherever a pipe line is given a reverse bend. That such connections had also been used in a heat exchanger *having neither shell, tube, nor tube sheet,* has no bearing on the question of the invention required to solve a leakage problem in a heat exchanger of the *shell-and-tube type.*

The third novel element recited in the claims, again quoting the language of claim 1, is the "spacing means maintaining said tube sheets in *nearly* fixed spaced relation to each other independently of said shell and said tubes" (emphasis ours). The Patent Office apparently took the view that this element was disclosed in the Brown Patent No. 1,856,618, and the Court below in its findings describes the disclosure of the Brown patent as follows (Appellant's App. 67):

> "8. The patent to Brown, No. 1,856,618, shows means for connecting the tube sheet of a tube assembly, rigidly at one end and with slight play at the other end."

This statement is a poor summary of the disclosure of the Brown patent. The Brown patent discloses no spacing means whatsoever for the tube sheets independently of the shell and tubes. As a matter of fact, there is no connection in the Brown patent between the tube sheets and their headers except the tubes themselves. The tube sheets in the Brown patent are heavy finned heat-radiating tubes which are straight—not bent—and which rigidly connect the tube sheets together in a unitary structure. There is no shell in the Brown structure in the usual acceptance of that term. The Brown structure is an air cooler for cooling air passing along a duct. The two tube sheets with their covering headers constitute two of the side walls of the duct, the other two side walls being made of sheet metal plates 15 (Appellant's App. 67) which are attached at one end to the tube sheet and at the other end have an interposed rubber strip 34 like a weather strip on a window, to fill in the space so that accurate fitting of the sheet metal side wall section is not necessary.

The tube sheets of the Brown structure have no connections between them except the tubes themselves, and the tubes being heavy rigid elements, form with the tube sheets a solid rigid structure. In the applicant's device the tubes and tube sheets alone are not rigid at all. Hence the need for the spacing elements recited in the claim, which elements are *entirely lacking* in the Brown structure. These spacing elements when added to the applicant's tube bundle do not form a rigid structure as in Brown—but serve to maintain the tube sheets in *nearly* fixed relation so that the shell which is entirely lacking in Brown and which in applicant's structure *is* a fixed rigid element, may be attached to the tube sheets without affecting the tightness of the joints.

The problem solved by the applicant's structure is not present in the Brown apparatus, and the elements making up the applicant's structure and recited in the claims are likewise not disclosed in the Brown patent.

Even if the two side plates of the air duct of the Brown apparatus be regarded as the equivalent of the shell of a tube-and-shell heater, the Brown patent still fails to disclose the applicant's structure which is essentially a structure of three elements—tubes, shell *and spacing means* independent of the shell and tubes. In the Brown patent the third element is entirely lacking.

It is submitted that the cited art falls far short of meeting the requirements necessary to negative novelty. In order to constitute valid grounds for the rejection of a patent claim for want of novelty the citation must disclose the structure claimed or the equivalent of that structure. A structure in the patent sense is the equivalent of another structure when it accomplishes the same purpose by the same or equivalent means.

As we have pointed out above, there is neither tube nor tube sheet in the Wilson structure and no problem of leakage to be solved. The Wilson structure is consequently not the equivalent of the structure recited in the claims. Likewise the structure of the Brown patent is in no sense the equivalent of the "spacing means" of the applicant's structure. The applicant's spacing means is added to the tube and tube sheet assembly to make a "nearly" rigid tube bundle notwithstanding the flexibility of the tubes. In the Brown structure the tube bundle is rigid without any added spacing means and none is provided. Brown discloses tubes and a casing arrangement which might be considered the equivalent of the applicant's shell, but the third element, namely, the novel spacing means, is totally absent. The Brown structure does not accomplish the same purpose as the applicant's, nor does it disclose the same or equivalent means.

Point II

The applicant's structure is a novel combination which would be patentable even were the elements per se old.

Even if the lower Court were right in its statement that the "various devices" making up the applicant's structure were old in the art, the conclusion that "bringing these various devices together was not an act of invention" would still be erroneous. It has frequently been held by this Court that a new combination of old elements is patentable.

> "It is no argument against patentability that appellant's invention consists in the combination of elements old in the art." *In re Buchanan,* 245 O. G. 1028, 46 App. D. C. 517.

See also:

> *Thornton* v. *Coe,* 102 F. (2d) 246, 69 App. D. C. 383;
> *Electrons* v. *Coe,* 99 F. (2d) 414, 69 App. D. C. 181.

To meet the broadest claim (claim 1) it is necessary, first, to assume that the Wilson patent shows the claimed arrangement of the tubes, the two tube sheets and the outside connections, and second, that the Brown patent discloses the equivalent of the applicant's spacing means, etc., and then assume that the heat exchanger of the early Price and Ris patent can obviously and without inventive skill be modified to incorporate the structure of Wilson and of Brown.

The Courts have frequently had occasion to condemn the practice of building up an anticipation by selecting this element from one patent and that from another.

Hirschy Co. v. *Wisconsin-Minnesota Gas & Electric Household Appliances Co.,* 18 F. (2d) 347, 354, 355;

Ottumwa Box Car Loader Co. v. *Christy Box Car Loader Co.,* 215 Fed. 362, 369 (C. C. A. 8);

Imhaeuser v. *Buerk,* 101 U. S. 647, 660.

It has also frequently been held that the selection from a crowded art of a particular specific device or sub-combination for solving a given problem may itself amount to invention even though the incorporation of the selected element in the finished combination involved no more than mechanical skill.

> "The specification of a mechanical combination patent generally discloses a machine consisting of a large number of elements, most of them individually old in the art. *The invention consists in the act of selecting* some of these elements for a combination which constitutes an independent entity, serviceable to the art and theretofore unknown. It is always this *choice* of the proper elements in combination which constitutes the invention." (Emphasis ours.) *H. Ward Leonard, Inc.* v. *Maxwell Motor Sales Corp.,* 252 Fed. 584, 593 (1918) (C. C. A. 2).

As the structure of the Wilson patent presents no leakage problem, it can hardly be said that the patent in any way aided in the selection of the elements making up the combination of tube, tube sheets and outside connections. Likewise as the Brown tubes and tube sheets alone constitute a rigid tube bundle, the Brown patent could not possibly aid in the selection of the "spacing means" devised by applicant to reinforce his flexible tube bundle. As has been frequently held by the Supreme Court, by this Court and other courts dealing with patents, and also the Patent Office, in order to negative invention in a new combination it is not sufficient to find in the prior art a device that might be modified to accomplish the improved result.

> "It is not sufficient to constitute an anticipation that the device relied upon might, by modification, be made to accomplish the function performed by the patent in question, if it were not designed by its maker, nor adapted, nor actually used, for the performance of such functions." *Topliff* v. *Topliff et al.*, 145 U. S. 156, 161.

See also:

> *Otto* v. *Robertson,* 66 F. (2d) 213, 62 App. D. C. 233;
> *In re Eastwood,* 144 O. G. 819; 33 App. D. C. 291.

> "In order to negative invention in a novel combination 'it is necessary to find in the prior art not merely a device which might be modified to make this construction, but somewhere a suggestion, not only that the modification ought to be made, but how to make it.'" *Ex Parte Gee,* 261 O. G. 850.

The Rejected Claims

We have discussed claim 1 in the foregoing portion of our brief for the reason that claim 1 is the broadest claim and its allowance will obviously carry with it the remaining claims. We will not individually discuss the remaining claims in detail. It is our position that the lower Court is in error in putting together even three patents, which is concededly the minimum necessary to build up an anticipation of claim 1. An attempt to apply the prior art to the remaining claims but emphasizes the error of the lower Court's position. For example, claim 3 includes two additional elements not recited in claim 1, namely, a supporting means for the tube bundle intermediate its ends and "additional spacing means maintaining said supporting means" in fixed spaced relation to each other and to one of said tube sheets.

In rejecting claim 3 the Patent Office adds the Wright patent 1,435,364 (appellant's affidavit) as a disclosure of "the supporting means between the ends of the tubes" which it says may be added without invention to the imaginary structure already built up out of the Price & Ris, the Wilson and the Brown patents in its effort to meet claim 1. The Patent Office merely ignores the other added element of claim 3, namely the "additional spacing means" having the defined characteristics.

Against claim 8 the Patent Office adds to the Price & Ris, Wilson, Brown and Wright combination forming the basis of its rejection of claim 3, the baffle structure of the Jones patent and the tube bundle support of Sieder.

Conclusion

We respectfully submit that the lower Court was in error in holding that the prior art disclosed separately all the elements of the combinations recited in the rejected claims, and that the claims should be allowed as directed to a novel combination of novel elements.

We further submit that whether or not the elements *per se* be novel, the claims are patentable as directed to a novel combination for the attainment of a new and useful result.

We further submit that the decree of the District Court should be reversed.

PENNIE, DAVIS, MARVIN & EDMONDS
Attorneys for Appellants

C. M. Fisher
W. B. Morton
Of Counsel

Dated: November 24, 1943

IN THE DISTRICT COURT OF THE UNITED STATES
FOR THE DISTRICT OF COLUMBIA

Civil Action No. 14,229

The Griscom Russell Company, 285 Madison Avenue
New York City, New York

Plaintiff

vs.

Conway P. Coe, Commissioner of Patents
Washington, D. C.

Defendant

Complaint For Issuance Of United States Letters Patent

I. The jurisdiction of this Court depends upon the Patent Laws of the United States, this Complaint being filed under Section 4915, Revised Statutes (Comp. Stats. 9460; U. S. C. Title 35, Section 63), as amended by Act of March 2, 1927.

II. The plaintiff, The Griscom Russell Company, is by proper assignment in writing acknowledged October 5, 1939 and recorded in the United States Patent Office on October 24, 1939 in Liber F181, Page 364 of the Transfer of Patents, the sole owner of the entire right, title and interest in an application for United States Letters Patent of Kenneth B. Ris for improvements in Steam Generator filed in the United States Patent Office on October 24, 1939, Ser. No. 300,907, and the improvements disclosed and claimed therein.

III. The Board of Appeals of the United States Patent Office in a decision rendered on the 12th day of July, 1941, refused to allow eight claims of said Kenneth B. Ris application, Ser. No. 300,907, to which The Griscom Russell Company is entitled, which claims are as follows:

> 1. A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet adapted to seal the other end of said shell, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.
>
> 2. A steam generator comprising a shell open at both ends having an internal flange at one end thereof and an external flange at the other end thereof and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof by engagement with said internal flange, another tube sheet adapted to seal the other end of said shell by engagement with said external flange, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.

3. A steam generator comprising a horizontal shell open at both ends and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet adapted to seal the other end of said shell, a plurality of horizontally bowed tubes extending inside said shell between and affixed at either end into said tube sheets, supporting means intermediate said tube sheets sustaining said tubes, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, additional spacing means maintaining said supporting means in fixed spaced relation to each other and to one of said tube sheets, said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.

4. A steam generator comprising a shell open at both ends having an internal flange at one end thereof, an external flange at the other end thereof and tracks spaced apart on the bottom of the inside thereof and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof by engagement with said internal flange, another tube sheet adapted to seal the other end of said shell by engagement with said external flange, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, supporting means intermediate said tube sheets sustaining said tubes and resting on said tracks, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, additional spacing means maintaining said supporting means in fixed spaced relation to each other and to one of said tube sheets, and removable fluid passages exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.

5. A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet adapted to seal the other end of said shell, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, removable fluid passages exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough, and spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, said spacing means being adapted to permit small limited longitudinal adjustment of the separation of said tube sheets.

6. A steam generator comprising a shell open at both ends having an internal flange at one end thereof and an external flange at the other end thereof and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof by engagement with said internal flange, another tube sheet adapted to seal the other end of said shell by engagement with said external flange, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, removable fluid passages exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough, and spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, said spacing means being adapted to permit small limited longitudinal adjustment of the tube sheet engaging said internal flange.

7. A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet

adapted to seal the other end of said shell, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, removable fluid passages exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough, rigid tie members connecting said tube sheets, said tie members being at one end rigidly affixed to one of said tube sheets and having at the other end transverse portions, said transverse portions having holes therethrough parallel to the axis of said shell, and fastening members passing through and having heads of greater diameter than said holes, said fastening members being affixed to the adjacent tube sheet and having when so affixed shank portions between said heads and said tube sheet longer than said hole whereby said tie members maintain said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes.

8. A steam generator comprising a horizontal shell open at both ends having an internal flange at one end thereof, an external flange at the other end thereof and tracks spaced apart on the inside of the bottom thereof and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof by engagement with said internal flange, another tube sheet adapted to seal the other end of said shell by engagement with said external flange, a plurality of tubes bowed in the horizontal plane extending inside said shell between and affixed at either end into said tube sheets, a horizontal baffle extending substantially the length of said shell above said tubes, supporting means intermediate said tube sheets sustaining said tubes and baffle and resting on said tracks, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, additional spacing means maintaining said supporting means in fixed spaced relation to each other and to one of said

tube sheets, and removable fluid passages exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.

IV. The defendant, Conway P. Coe, Commissioner of Patents of the United States, by the aforesaid decision of the Board of Appeals of the United States Patent Office, has refused and still refuses to grant Letters Patent of the United States to the plaintiff, The Griscom Russell Company, as assignee of said Kenneth B. Ris, on his application Ser. No. 300,907, including said eight claims recited in Paragraph III hereof.

V. The said decision of the Board of Appeals was rendered on or about the 12th day of July, 1941, and within six months last past, and no appeal has been taken from said decision of the Board of Appeal to the Court of Customs and Patent Appeals, and no such appeal is pending or has been decided.

WHEREFORE, the plaintiff, The Griscom Russell Company, demands that this Honorable Court authorize the Commissioner of Patents to issue to plaintiff, The Griscom Russell Company, Letters Patent of the United States embodying said claims 1 to 8 inclusive, upon the filing in the United States Patent Office of a certified copy of such adjudication, and upon compliance with the requirement of the law in such cases made and provided.

THE GRISCOM RUSSELL COMPANY
By Clarence M. Fisher
National Press Building
Washington, D. C.

W. B. Morton
Of Counsel

Answer To The Complaint.

To the Honorable the Justices of the District Court of the United States for the District of Columbia.

I. Defendant admits the allegations of paragraph I.

II. He admits the allegation of assignment to plaintiff by Kenneth B. Ris of his patent application No. 300,907, which was filed in the Patent Office on October 24, 1939, and entitled Steam Generator. He denies, for reasons hereinafter given, that the subject matter claimed in said application constitutes a patentable invention.

III. He admits that the Board of Appeals of the Patent Office, in a decision rendered on July 12, 1941, refused to allow claims 1 to 8, inclusive, of said application, which claims are as set out in paragraph III. He denies that plaintiff is lawfully entitled thereto as it is deemed that the said claims are unpatentable in view of the following prior patents and for the reasons given in the statement of the examiner in answer to the appeal and the decision of the Board of Appeals, copies of which will be furnished at the trial:

Wright,	1,435,364,	Nov. 14, 1922,
Jones,	1,617,119,	Feb. 8, 1927,
Wilson,	1,737,347,	Nov. 26, 1929,
Price et al.,	1,842,945,	Jan. 26, 1932,
Brown,	1,856,618,	May 3, 1932,
Sieder,	2,018,037,	Oct. 22, 1935.

Profert of copies of these patents is hereby made.

IV, V. He admits the allegations of paragraphs IV and V.

W. W. COCHRAN,
Solicitor, U. S. Patent Office,
Attorney for Defendant.

February 2, 1942.

I hereby certify that a copy of this ANSWER TO THE COMPLAINT WAS MAILED today, February 2, 1942, to the attorney for plaintiff, Clarence M. Fisher, National Press Building, Washington, D. C.

W. W. COCHRAN,
Solicitor.

Opinion Of The District Court

The plaintiff complains of the refusal of the Patent Office to issue a patent to it on the application of its assignor, Kenneth B. Ris, Serial Number 300,907, and proceeds under R. S. § 4915 (35 U. S. C. A. § 63) to obtain an order authorizing the issuance of the patent.

The application states that the invention relates to improvements in bent tube self-scaling steam generators and that the improvements of "my present invention" are directed particularly to structural changes in bent tube self-scaling evaporators particularly adapting them for use in oil refineries and the like.

Eight claims are involved and were held unpatentable in view of the prior art as exemplified in the following patents:

Wright,	1,435,364,	Nov. 14, 1922,
Jones,	1,617,119,	Feb. 8, 1927,
Wilson,	1,737,347,	Nov. 26, 1929,
Price et al.,	1,842,945,	Jan. 26, 1932,
Brown,	1,856,618,	May 3, 1932,
Sieder,	2,018,037,	Oct. 22, 1935.

Claim 1 is typical and reads as follows:

> "A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet adapted to seal the other end of said shell, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to

> said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.''

This claim was made the subject of cross-examination of the inventor, K. B. Ris (R. p. 24 et seq.) and he frankly admitted that certain portions of the claim were not new. Apparently these various devices were adapted for the specific purpose for which they were used in the prior art. What the applicant has done, so far as stated in the claims, was taught by the prior art and, therefore, merely bringing these various devices together was not an act of invention. Such was the view taken by the Board of Appeals. In affirming the decision of the Examiner, the Board said:

> ''Without discussing the claims in detail, we agree with the examiner that they involve nothing more than a mere bringing together, in a single structure, of various features which are all old in the art. It has repeatedly been held that the mere aggregation of old features, even though the assembly may produce a superior device, does not amount to invention. See, in this connection, the Supreme Court decision of Hailes v. Van Wormer, 20 Wall. 353; Stove Co. v. Kelsey, 158 Fed. 622; *Ex parte* Fine, 364 O. G. 511, 1927 C. D. 84, and *In re* Small, 271 O. G. 363.''

In the case of In re Fridolph, 134 Fed. (2d) 414, relating to bandages and the method of making the same, the application was rejected on the ground that the applicant had done nothing more than employ features of the prior art in constructing the bandages and in doing so had only exercised the skill of the art. The court said at page 416 of the opinion:

> ''Appellant emphasizes that 'there is no reference which shows the invention.' This may readily be agreed to, but it is entirely proper to consider several refer-

> ences in connection with the allowance of patent claims. It is also inferred from appellant's argument that some of the references should not be considered since they do not relate to bandages. In considering more than one reference, or a reference alleged not to be in the art involved, the question always is: does such art suggest doing the thing which the applicant has done? We think the art of record clearly suggests doing what appellant has done.
>
> "It may be that appellant has produced a bandage that has all the good qualities claimed for it and that it is a distinct improvement over the art (although there is nothing of record to show this to be a fact, except the statement of appellant's counsel and appellant's application). This, however, does not necessarily mean that appellant has invented a new article. Invention must be present."

The claims are not patentable and, therefore, the complaint must be dismissed.

It is so ordered and counsel for defendant will prepare and submit appropriate findings of fact and conclusions of law accordingly.

O. R. LUHRING,
Justice.

June 7, 1943.

Findings Of Fact

1. This is an action brought under the provisions of Section 4915 R. S. (U. S. C. title 35, sec. 63), in which the plaintiff seeks to have the Court adjudge that it is entitled to receive a patent on the application of its assignor, Kenneth B. Ris, Serial No. 300,907, filed October 24, 1939, containing claims 1 to 8, inclusive, of said application.

2. The Ris application in suit relates to improvement in bent tube, self-scaling steam generators and particularly to a waste-heat boiler generating steam from water in a shell by passing hot tar, or other gummy residues from a petroleum cracking process, through it in bent tubes.

3. The apparatus of the application comprises a heat exchanger of the shell and tube type, the tubes, which are bowed, being secured rigidly to two sheets bolted to the ends of the shell. As shown in the drawing, the left-hand tube sheet is smaller than the internal diameter of the shell and the right-hand tube sheet is bolted to an outside flange on the shell. The tubes are bowed so as to absorb the expansion between the tubes and the shell. Return bends are clamped on the outer sides of the tube sheets to provide fluid connections between the ends of different tubes. A longitudinal baffle sheet is placed over the tubes to prevent entrainment of water in the steam. This baffle sheet is supported on longitudinal members rigidly fastened to one of the tube sheets and held in nearly fixed relation to the other tube sheet, so as to permit expansion relative to the shell. The tubes are provided with supports intermediate their ends, which may be moved along tracks on the bottom of the shell.

4. The patent to Price et al., No. 1,842,945, discloses a heat exchanger of the same type as that shown in the Ris application having bowed tubes attached to the tube sheets with provision for the expansion and contraction of the means which tie the two ends together.

5. The patent to Wilson, No. 1,737,347, shows a heat exchanger comprising a block of metal having fluid passages therein, and connections between different passages on the outside of the block.

6. The patent to Wright, No. 1,435,364, discloses tracks for facilitating the moving of a tube bundle into or out of a shell.

7. The patent to Sieder, No. 2,018,037, shows tube supports which are held in fixedly spaced relation by a combination of sleeves and rods.

8. The patent to Brown, No. 1,856,618, shows means for connecting the tube sheets of a tube assembly, rigidly at one end and with slight play at the other end.

9. The patent to Jones, No. 1,617,119, shows a baffle placed over the tubes of a tube and shell assembly, when used as an evaporator to prevent the entrainment of the liquid.

10. It was not invention to bring the aforesaid various features, old in the art, into a single structure.

11. None of the claims of the Ris application involved herein defines any invention over the prior art cited by defendant.

CONCLUSIONS OF LAW.

1. The plaintiff is not entitled to a patent on the application of Kenneth B. Ris, No. 300,907, containing claims 1 to 8, inclusive, or any of them.

2. The complaint should be dismissed with costs against the plaintiff.

O. R. LUHRING
Justice

Final Judgment

IN THE DISTRICT COURT OF THE UNITED STATES

For the District of Columbia

Civil Action No. 14,229.

The Griscom Russell Company,
Plaintiff,
v.
Conway P. Coe, Commissioner of Patents,
Defendant.

This action came on to be heard at this term and thereupon, upon consideration thereof, it is this 21st day of June, 1943

ADJUDGED that the complaint in this case be, and the same hereby is dismissed with costs against the plaintiff.

O. R. LUHRING
Justice

Approved as to form:
Clarence M. Fisher
Attorney for Plaintiff

Testimony Of Kenneth B. Ris

Direct Examination by Mr. Morton:

Q. Please state your full name. A. K. B. Ris.

Q. Where do you reside? A. Garden City, Long Island.

Q. By what company are you employed? A. The Griscom Russell Company.

Q. That is the plaintiff in this action? A. Yes, sir.

Q. How long have you been employed by that company? A. Twenty years and five months.

Q. What is the nature of your duties? A. I am now called a sales manager, but I am still mostly an engineer, a heat transfer engineer, graduating from the Yale University in 1918. I studied mechanical engineering, but most of my time is spent on heat transfer problems, particularly with the petroleum industry.

Q. And you are the inventor of the device illustrated in the application? A. Yes, sir.

Q. Will you take the drawing, Plaintiff's Exhibit 1-A, and explain to the court the construction of the apparatus? A. There are a number of important features, some of which are old, but the tube bundle is removable for investigating and cleaning. The most important feature, which does not show too clearly on this drawing, is the fact that those tubes extend completely through the tube sheets.

The Court: Is this the proper view of it (indicating)?

The Witness: That is the plan view, sir, and just below is the elevation. It lies horizontally.

The Court: That is what I mean.

The Witness: These tubes extend completely through the tube sheets, and these connectors shown at the left hand end and similarly at the right hand end, make up the joint directed against the ends of the tubes. The important thing is that it is usually used under very high pressure and high temperature, running between 800 to 1,000 pounds pressure in the tubes, and it would be fatal to let these high temperature gases get into the boiler system. You might have an explosion. So we make the joint in such a way against the outside of the tube that if there were any leak it would be around the outside rather than into the other fluid. Similarly, if we were running at a lower temperature of the gas and did not want this high pressure water to get into the baffle column, if you were fractionating gasoline, the water, if it leaked out along that tube, would also go into the air rather than into the other fluid. The thing that is different between this and other designs of similar character is the fact that you cannot have another liquid go from one side to the other unless the tube itself should completely rupture. That is new and different.

The Court: Is that the distinguishing feature?

The Witness: That is the distinguishing feature. It is an improvement over previous types of apparatus which I have also designed for other plants. We had nothing in our line at the time this job came up which would handle this specific problem. But it was so well handled that the customer has bought an additional unit and is using them to make 100 octane gasoline sold to the United States Army.

There is a second feature, in that once gases start through this passage (indicating on drawing), this is an absolutely simple continuous cross-section. These joints are so made that there is no change in cross-section. Therefore we maintain a high velocity, so that any materials in that case flow right on through the unit.

The Court: It comes in at 29?

The Witness: It comes in about 8 or 10, passes through these tubes, and comes out at 28.

By Mr. Morton:

Q. Suppose you just trace the action of the gas. A. It comes in at this point here (indicating). It travels at high velocity. You can slow it down just like you put a snow fence on the side of the road. You change the velocity of the wind and the snow will drop. With this high velocity there is no chance for the coke to drop out. It maintains that high traveling rate for long periods of time, due to that feature which does not exist in previous apparatus of this type.

Q. I call your attention there to Figure 5 on the drawing. What does that show and what is the purpose of the device shown there? A. At Figure 5 there is a shoulder bolt which attaches a thrust member which extends from this tube sheet to the other tube sheet. We have here some bowed tubes which would tend to straighen out if they were not restrained by these thrust members. When this tube bundle is outside of the shell this thrust member and another down below maintains a relationship between this tube sheet (indicating) and this tube sheet (indicating). But it is impossible in a device such as this, which is roughly 48 inches in diameter and 24 feet long, to make up a gasket joint. They must match precisely. You have to allow the manufacturer a tolerance. This tube sheet would be a little longer in space than the other part it connects up with. When you bow this into place, tube sheet 13 will make up against flange 16 before tube sheet 11 makes up against flange 17. This little plate that is in here (indicating) allows that thrust member to move a little bit, and the tubes will bow a little further and you can maintain a pressure-tight joint at both places. That is a necessity in the fabrication of the unit.

The Court: Is it used to loosen or tighten? Is it used for that purpose at all?

The Witness: In the original designing of this unit you had to have these tubes with relation to one another, so that the tubes will have their proper bow, so that you can remove the bundle and replace it without having it jiggle all around the place.

The Court: What is the purpose of having these tubes bowed?

The Witness: In order to take care of differential expansion. This shell will have a temperature of about 400 degrees.

The Court: The outside shell?

The Witness: Yes, because it is full of water and steam at that temperature. But the tubes have gases inside around 900 to 950 degrees. We have a difference between the water and gas temperature somewhere around 450 to 500 degrees. So these tubes, when they are in operation, will be bowed out almost to where these other bolts show, another six or eight inches beyond what they are now; and they are there to take care of that differential expansion in this particular device.

By Mr. Morton:

Q. What temperature is the water heated to in this apparatus usually? A. It will run anywhere from power steam purposes, which is apt to be anywhere from 360 degrees, to around 450 degrees. It usually runs within that range because we seldom use steam much over 450 pounds.

The Court: Is that Fahrenheit temperature?

The Witness: Yes, sir. It is twice as high as the radiator in a house.

By Mr. Morton:

Q. That produces steam at boiler pressure? A. Yes, sir. You can drive a steam pump or make electricity with it or drive a turbine. They use it for power purposes, and it saves burning fuel oil which you would have to substitute in order to make the equivalent power.

Q. I take it the oil comes out of the tube at a reduced temperature after making these six or eight passes through the water. The temperature is reduced to what? A. In this particular case around about 500 degrees, and then it goes through an air-cooled vessel and then to a fractionating column. You have to cool it down around 250 to 300 degrees in order to fractionate. To use it in your aviation gasoline you must first cool it down, and it is a very difficult problem for the company that has this job to do.

Q. You referred to the tube bundle. I do not know whether the court caught exactly what you meant by that. Will you please explain, referring to the drawing, what parts make up the tube bundle? A. The tube bundle consists of tube sheet 13 at the left and tube sheet 11 at the right; the thrust members, which I think are No. 20, are shown, which connect the tube sheets together, the bowed tubes, which I believe are No. 25, and supports for those bowed tubes, No. 22, which are slats, permitting the tubes to lead in a horizontal direction and supporting them so that they will not sag. That permits of movement in one direction for the purpose of expansion and contraction. To that tube bundle are attached these returns and connecters, so that when you pull the bundle out they come out with it. If you want to clean the inside where the dirt is, you do not have to break these large gasketed joints. You merely take off these little pieces—you can hold one of those in your hand; it is only about five or six inches and weighs probably ten or fifteen pounds. They are marked 14. Those can be removed, and then you clean the inside of the tubes with a power-driven tool without having to take the big apparatus apart. On the shell side we have the clean fluid. It does not get dirty. It is pure condensate. It is distilled water such as you would put into the battery of your car.

Q. These connections, 14, are U-shaped designs, are they not? A. They are cast, and they are the same inside diameter and match up exactly to the end of the tubes, and there is a spherical joint that matches so perfectly that you do not need any gasket.

Q. They are clamped against the end of the tube shown in Figure 4; is that correct? A. Yes.

Q. Those are plates held by the bolts back of the U tubes to draw them tight against the end of the bowed tubes; is that correct? A. That is correct, sir.

Q. So that each pair of the tubes may have a continuous oil passage without change in cross-section? A. That is right.

Q. What advantage is that arrangement over the customary arrangement of covering the tube sheet on the outside with a cap or manifold? A. If you covered the tube sheet on the outside with a cap you would have a high temperature against one side of the tube sheet.

Here (indicating) is a sketch of another type with a cap over it. If you had a cap such as that you would have hot gas on this side (indicating) and cold water on the other side, and this big tube sheet would tend to bow out in this direction (indicating) and you would not be able to maintain a tight joint. We can speak from experience, because we have seen that actually happen where we put hot gases against one side of the sheet and cold water on the other. That is why we use the construction shown at the top of the drawing.

The Court: That connection you have here permits circulation; is that the idea?

The Witness: That is right, sir. The gas passes through there. It does not go back to where it came from; it goes back and forth in these tubes, but it goes to another area of the plant entirely. We have a relatively cool tube sheet by having these small connectors, rather than a cap which covers the whole thing. That is the difference between this and other devices that existed before.

By Mr. Morton:

Q. I call your attention to Patent 1,842,945, the Price patent; that is, Price and Ris—Mr. Ris was one of the joint inventors of that apparatus, and this patent is owned by the plaintiff company. I would like you to take that patent and explain to the court, first of all, whether that apparatus could be used as shown there for the service for which the apparatus of the application in suit may be used. A. No, sir; it would not serve the purpose at all.

Q. Will you please explain to the court why that apparatus which has a bowed tube, and really is a heat exchanger, would not serve the purpose? A. Yes, sir. In the first place, you have here a relatively large head in Figure 1 and Figure 2. They both show a large head at the left hand side. It would be very difficult to design a joint between Part 13 and Head 8. There is a separate channel here (indicating) and there is a joint at the left hand end of that. It would be very difficult to design a joint of that sort for 900 degrees. I do not think anyone is doing that very successfully in the size we need here.

The Court: What is this designed for?

The Witness: For condensing vapors at around 500 to 100 pounds maximum, with the vapors in the tubes. But where this joint was we had a relatively low temperature, probably only about 500 or 600 degrees as compared with 950 in this other proposition. Also that high velocity was not a factor in that case. You see, each time you come into one of these chambers the velocity slows down, and that that would permit coke to pile up and block off some of the tubes, and you would rapidly lose the efficiency of the apparatus. If you tried to build this heavy enough to do this job you would get a very expensive vessel and it would probably only last one or two weeks in service before you would have to clean it, whereas this (indicating drawing) will run three or four months without cleaning, which means a big saving to the operator in that he does not have to shut his plant down to clean this vessel.

Secondly, the tubes in this vessel in Figure 1 are rolled into a tube sheet. You put a mandrel with rollers on and expand those tubes against the tube sheets to make the joint. It is difficult to make a joint which will be permanently tight, and therefore, with a tube, say, of this fluid here (indicating) and another fluid here (indicating), you cannot maintain a tight joint if it starts to leak. And those things have happened under severe conditions.

In this other one there is no chance that that will happen, because these connecters come right against the edge of the tubes and there is no possibility of leakage. It cannot leak.

By Mr. Morton:

Q. In the apparatus described in the application, any leakage is to the outside where it just drops down on the ground instead of into the other fluid? A. That is right. It is important not to allow these fluids to mingle. The two fluids must be kept separate.

The Court: Oil and water never mix, do they?

The Witness: They are good things to keep apart.

By Mr. Morton:

Q. Is the arrangement for taking up the manufacturing tolerances shown in Figure 5 of the application drawing provided for in the structure of the earlier Price et al. patent? A. No, sir. We use an entirely different device. If you will notice, there are tie-rods.

Q. Referring to Figure 2, the tie-rods, 29'. A. 29, 30 and 29'. But they do not go direct from tube sheet to tube sheet; they go through a relatively thin plate at No. 24 and 24'. They are supposed to give a little bit and take care of the slight difference in the tolerance. I think the shoulder bolt is a distinct improvement over this method we used 13 years ago.

Q. I call your attention to the Wilson patent, No. 1,737,347, and ask you to tell us what sort of heat exchanger is shown in the Wilson patent. A. This exchanger shown on Figure 3 is a solid block of metal, probably casting, through which a number of holes are proposed to be drilled from end to end. This is a cast block of metal probably 20 feet long in the direction of the depth of the paper, and these holes extend clear through the block from end to end. On this end (indicating) are connecters. On the ends of the block, on Figure 6, there is shown an external connecter on the end of the block. There is a number of different ways of applying those, so that a fluid which enters one end passes through one tube and goes to either one of these connecters and comes back through the next tube.

Q. That is somewhat like yours, is it not? A. It is equal in cross-section, as near as I can tell, but the joints are quite differently made. They do not make up against the end of the tube at the tube sheet as we do. I cannot be sure.

Q. He does reduce the leakage somewhat with this, does he not? A. I imagine it would be a tight joint. I have no knowledge that one of these has ever been built. It is more or less a theoretical design. The company which owns this patent buys our device. For duties for which this unit would be suitable they have a number of our units in their various refineries, and to the best of our knowledge they have never built one of these. They have depended on another invention of ours which is somewhat similar to this, but is made for a different purpose. This is primarily for liquid heat transfer with two dissimilar fluids. One set of tubes would hold one fluid and another set would hold another fluid. The whole block takes on a temperature somewhere between those two fluids, and the heat has to travel a rather long distance from one end to the other.

Q. There is no shell or tube shown in this construction, is there? A. No. Both fluids travel through the inside of the tubes, but the tubes are so far apart that the cost of a device like this and the amount of metal required would be against the WPB regulations today.

Q. You mean, holes in the cast iron. They really are not tubes at all, are they? A. That is right, sir.

Q. Just holes bored through a solid block? A. Yes.

Q. I suppose the hotter of the two fluids heats up the block and the cooler one has to cool it down, and the heat passes merely by conduction through the metal from the hotter liquid to the cooler. Is that right? A. Yes. It is five or six inches, according to the drawings; whereas in our device you have a thin wall about one-tenth of an inch thick.

> The Court: It is just to allow for expansion?
>
> The Witness: You heat it up and hope that it doesn't break something loose. There is no way to take care of the expansion.
>
> The Court: You take care of it in your device, do you not?
>
> The Witness: Yes, sir, by these bowed tubes. In my opinion, this device could not be used for the purpose that we use ours.

By Mr. Morton:

Q. You could not have any such temperature conditions as you employ in your method? A. No, sir. We tried a device something like this on temperatures much lower than this one.

Q. It tends to stretch around the hot fluid and to shrink around the cool one, and that would rupture the system? A. Yes. It has actually happened in practice.

Q. I call your attention to the Jones patent, No. 1,617,119. That also is a Griscom Russell patent, so I suppose you are familiar with the structure there shown? A. Yes.

Q. What is the purpose for which that apparatus was designed? A. That apparatus was primarily for producing distilled water for boiler feed, using hot steam as the heating medium. Steam for heating medium might be anywhere from 50 to 100 pounds, and the vapor is normally produced at a low pressure, maybe 5 to 10 pounds. The water which you have made is used later to feed the boilers. It does not produce steam at high pressure for power purposes.

> The Court: I notice you have these tubes slightly bowed.
>
> The Witness: That is correct. These tubes are bowed. These are made of a non-ferrous material and they do shed scale in any change of temperature. In this unit we used actually dirty water, unfit for drinking or unfit to put into the boiler. So this scale forms on the tubes, and later we took the water out of the shell and filled it up with cold water and then we give it a sudden temperature shot with hot steam, and the scale flakes off the tubes. That is the purpose of the bowed tubes, to shed scale.

By Mr. Morton:

Q. Apparatus of this type are used on shipboard, are they not, for making boiler water out of sea water? A. Yes, sir.

Q. And there is a great deal of scaling from sea water when you distill it? A. Yes, sir; that is correct.

Q. The Brown patent is also a Griscom Russell patent. I seem to have only a photostat of that. You are familiar with the structure, are you not? A. Yes, sir.

Q. Will you explain to the court what that apparatus is and what it is used for? A. This apparatus consists of a bundle of thin tubes, Figures 6, 7 and 8. Six and 7 show a picture of a tube. It has a helical fin wound on the tube. The exterior surface is perhaps 8 to 10 times the interior surface; and that device is used for cooling water from around 150 degrees to around 104 degrees. The air is very reluctant to give up its heat; so you can apply more surface to the air than you do to the water. The air is circulated through the coils of the generator to maintain the temperature at a low level so the wires do not get overheated and burn off the insulation.

Q. This structure is something like an automobile radiator, except that you have the cooler water inside? A. It is just the reverse. An automobile radiator uses fins similar to this; but we are cooling hot water with cold water.

Q. Referring to Figure 1 in the Brown patent, will you tell us in what sort of frame or support the tubes are mounted? A. The tubes are rolled into a tube sheet at each end with a cap over it, and there is an angle frame which connects along one tube sheet and extends to a member at the back end, shown at 14. But the casing is apt to be at a somewhat different temperature from the tubes, so we insert between the back tube sheet and that casing a gasket at 34. That is shown in the lower right hand corner in the view of Figure 3.

> The Court: It is shown in Figure 1 also, is it not?
>
> The Witness: It is not very clear there. It shows at 36, 14, and 33. It is enlarged in the Figure 3 view.

We used up to now a compressible rubber gasket, a very soft rubber gasket. Just now we are trying to find a substitute. We pull the tube sheet tight against the frame and compress the gasket and the tubes themselves hold this back tube sheet against the gasket and against this framework. But in actual operation, if the tubes were a little hotter than the shell, it could move away a little bit and this gasket would still seal at that point and prevent air from the outside reaching the generator circuit. That is purely a gasket, and it is stretchable to take care of an expansion of only one-eighth of an inch.

By Mr. Morton:

Q. In the application drawing it extends some five or six inches? A. The tubes will move sideways a matter of 8 inches, but the tube sheets in operation stay fixed.

Q. But the tubes themselves expand and make a movement of at least 8 inches? A. Yes. This varies between 100 and 150 degrees. In our other device we are up around 900 degrees.

Q. Is that approaching red heat? A. At night you can just about see it. At 900 to 950 it would have a red glow, and if you even stood within four or five feet of it you would feel the heat on your face as though you were standing by an open fire.

Q. This Wright patent, No. 1,435,364, is not a Griscom Russell patent, but I believe you have looked it over. Tell us whether you see anything in that patent which has any similarity to the structure in the application here in suit. A. No, sir; I do not.

Q. What is that device? A. A hot water heater for an apartment house or something of that nature, where steam would be inside the tubes and water in the shell would be heated around 140 degrees to take care of washing purposes and the like. It is a low-temperature low-pressure device. Most of the tubes are built with a U bend. The steam goes down one and comes back the other. It is a very simple device.

Q. The tubes are carried by this one head, No. 10, so that the whole thing can be taken out? A. The whole thing can be removed.

Q. The sixth patent cited in the answer is the patent to Sieder. That is a patent belonging to the Foster-Wheeler Corporation. Are you familiar with the structure of that device? A. Yes, sir.

Q. What is an apparatus of that kind used for? A. It looks something like an oil vapor condenser, obviously for low-pressure and low-temperature duties, and would normally have cooling water flowing through the tubes in fairly large volume and at low pressure and temperatures. The vapors would enter the nozzle shown at the top right of Figure 1 and be condensed in these tubes. It is an open work support method so that the vapors can freely flow. The ports consist of slats which are shown better on Figure 2 and Figure 3, where the slats go in between the two, and the purpose is to prevent the tubes from rubbing on one another. But when you get these slats going in both directions, some in this way and some the other way (illustrating), that prevents the tubes from moving in any direction.

In our device we have a single row of slats deliberately permitting the tubes to move in the horizontal direction to take care of expansion. In this device he has a movable head shown in Figure 1, the entire ensemble consisting of a cap, 24, a tube sheet, 17, a ring, 25, that is free to move when the tubes are a different temperature from the shell; whereas in our device the tube sheet stays rigid and our tubes flex to take care of this differential. Our tubes are designed to permit of that.

Q. In your opinion, could this apparatus be used under the conditions for which that application is designed? A.

Absolutely not, sir. It could be built for half the price, but the customer would not think of trying to use this kind of an apparatus for his purpose.

Mr. Morton: That is all.

Cross Examination by Mr. Whitehead:

Q. Let me ask you some questions about the claims. I will take Claim 1, which reads this way:

> "A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet adapted to seal the other end of said shell,"—

Is that new? A. No, sir.

Q. "a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets,"— Is that new? A. No, sir.

Q. "spacing means maintaining tube sheets in nearly fixed space relation to each other independently of said shell and said tubes"— Is that new? A. Yes, sir.

Q. There is nothing in this record that shows that spacing? A. No, sir.

Q. As you say, there is no patent here which maintains the tube sheets in space relationship to each other independent of the shell and the tubes? A. We have that special bolt which permits you to have a clearance on either side so you can bring it together and bow the tubes a little more as you bring them into position.

Q. And that is not shown in any of the others? A. No, sir. We had a tremendous discussion about that particular device, because we first said we could not make this thing at all. We had to put it on to make it possible for the shop to build this unit.

Q. But none of these old devices show any means whatever like that? A. Nothing like that, sir.

Q. This claim does not specify how this is done. It says:

> "spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes."

Is there any old device that does that? A. No, sir.

Q. "said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement"— Is that old in the art? A. That is new, sir.

Q. Does not Wilson show the exact equivalent of it, in which you have openings through the block which correspond with the tubes connecting at the end exactly the same way? A. But that is not a tube sheet, sir, restraining a fluid inside of a shell.

Q. It does connect the ends of the holes through which the liquid passes in just the same way that you connect it here, does it not, so that you have the same effect as a liquid? A. It maintains a cross-sectional area; but he does not make his joint against the end of the tube, and there is no fluid on the other side. Take this piece of metal here (indicating): there is no fluid on the other side of it.

Q. But the passage of the liquid is around that bend, is it not—the liquid itself, as it moves into this opening? A. Yes; the liquid does that.

EXHIBIT A

Specification—Ris Application 300,907

This invention relates to improvements in bent tube self-scaling steam generators. The inventions in the prior art dealing with that well-known type boiler are directed chiefly to the solution of the scale formation problem arising, for example, in make-up water evaporators fed with sea water. The improvements of my present invention are directed particularly to structural changes in bent tube self-scaling evaporators particularly adapting them for use in oil refineries and the like.

The embodiment of my invention which I have illustrated in the accompanying drawing is intended for a waste-heat boiler generating steam from water in a shell by passing hot tar or other gummy residues from the petroleum cracking processes through it in bent tubes. The bent tube type of steam gėnerator is particularly useful in this field because the water available at many refineries, particularly in the Middle and South West, is hard and the resulting scale forming on the outside of the heating tubes impairs the efficiency of the generator. However, the use of cracking still residue as the heating demands ready accessibility to the heating tubes for cleaning purposes. Moreover, the fluctuations in quantity and character of the supply of heating medium available in oil refineries make a ready flexibility of tube connections important, and such flexibility permits a substantial saving in cost of manufacture by increasing the number of different installations possible with apparatus of standardized construction.

The objects of my invention, therefore, are to provide a self-scaling steam generator which is structurally adapted for ready cleaning and disassembling and to permit a high degree of flexibility in the number of tubes per pass as well as in the number of different sources of heating liquid which may, from time to time, be applied to one generator installation.

I have accomplished this broadly by employing a removable bent tube bundle unit assembly in which the individual tubes are expanded at both ends into independently spaced tube sheets, the fluid connections between these tubes being made by U-bends or headers as the volume and temperature of the supply of heating fluid may require. This assembled tube bundle unit is inserted in a shell open at both ends, but adapted to be sealed by the opposite tube sheets of the tube bundle. By this novel arrangement all inter-tube connections are made wholly exterior to the shell permitting easy cleaning out of the tubes and rearrangement of the passes without any disassembling of the shell structure.

For a description in greater detail of the best embodiment of my invention now known to me, attention is directed to the accompanying drawings, in which

Fig. 1 is a sectional plan through a steam generator constructed according to my invention;

Fig. 2 is a sectional elevation taken on the line 2-2 of Fig. 1;

Fig. 3 is a vertical section taken on the line 3-3 of Fig. 2;

Fig. 4 is an elevation of the tube inlet and outlet end of the steam generator shown in Fig. 1;

Fig. 5 is a detailed drawing on an enlarged scale of the structure by which the tie-rods connecting the inserted tube sheet to the opposite tube sheet are fastened to the former; and

Figs. 6 and 7 are sectional plans diagrammatically illustrating some of the possible heating fluid flow variations in steam generators embodying my invention.

In Figs. 1-5 illustrating a preferred embodiment of my invention the shell 10 is provided at one end thereof with the external flange 17, at the opposite end with the internal flange 16 and with the customary appurtenances such as blow-down connections, safety valve and gauge glass and clean-out plates. Inside the shell 10 and spaced apart parallel on the bottom thereof are welded two tracks or rails 15. Feed water is admitted to the shell 10 through the inlet connection 23 and the steam generated therein is withdrawn through the vapor outlet 24.

The assembled tube bundle unit 25 is built up as follows: The heating tubes 12 are bowed as shown on the horizontal plane and expanded at each end into the tube sheets 11 and 13. The radius of curvature imparted to the tubes 12 is sufficiently large to permit passage of tube cleaner through them, thus removing, when necessary the deposits left by the heating medium therein. This radius is nevertheless sufficiently short to permit adequate flexibility in the tubes 12 to absorb the differential expansion between tubes 12 and shell 11. This function of the bow in the tubes 12 is of great importance to the simplicity of the structure of my invention. Tubes 12 are supported along their length by the spaced tube supports 22. The smaller inserted tube sheet 13 is constructed of such diameter that it will pass readily through the shell 10 clearing the track 15 and engaging the inner flange 16. The larger tube sheet 11 is of diameter corresponding to the outer diameter of the flange 17 on the shell 10. The tube sheets 11 and 13 are held in substantially fixed spaced relation to each other independently of the shell 10 and the bent tubes 12 by the tie members 18, here constructed of steel angles. The tube supports 22 are held in fixed spaced relation to each other and to the large tube sheet 11 by the tie-rods 19 and spacing tubes 20. A horizontal plate baffle 21 to prevent entrainment of water in the steam is welded on blocks above the tubes 12 to the upper tie members 18.

The tube bundle 25 thus comprises tubes, tube sheets, tube supports, baffle and spacing means for holding these various elements in their proper relation to each other assembled together independently of the shell 10 into which it may be inserted as a unit. When so inserted, the legs 30 of the tube supports 22 are borne by the track 15 and the tube sheets 11 and 13 are in proper position to act as covers for the open ends of the shell 10. The larger tube sheet 11 is bolted to the outer flange 17 sealing the shell 10 at that end with a steam tight connection. The smaller inserted tube 13 is similarly bolted to the inner flange 16 sealing the shell 10 with a steam tight connection at the opposite end.

The method of fastening the tie members 18 to tube sheet 13 is shown in detail in Fig. 5. This method of construction permits the tube sheet 13 to be drawn into steam tight connection with the flange 16 without requiring prohibitively expensive precision of manufacture while at the same time permitting the tube sheet 13 to be held in sufficiently accurate spaced relation to the other assembled parts of the tube bundle 25 to permit its withdrawal and insertion as a unit. The connection is made by employing the shoulder bolt 27 to fasten the tube sheet 13 to the tie member 18, passing it through the block 26 which is welded to the end of the tie member 18 adjacent to tube sheet 13. The shoulder bolt 27 consists of the threaded portion 31, the enlarged barrel portion 32 and the head 33. This bolt is inserted through a hole in the block 26 and drawn up tight into the tube sheet 13, engaging the forward end of the barrel portion 32 against the inner face of the tube sheet 13. The length of the barrel portion 32 is, as shown, substantially greater than the thickness of the block 26 thus permitting a certain amount of longitudinal play in the connection between the tube sheet 13 and the tie member 18.

When thus assembled the steam generator consists of the tube bundle 25 enclosed within the steam tight shell 10, but with the ends of the tubes 12 through tube sheets 11 and 13 to the outside of the shell 10 as yet unconnected. These tubes may be readily interconnected in a variety of ways. As illustrated in Figs. 1-4, the tubes are interconnected to provide six separate channels for the passage of the heating fluid through the tubes 12, the fluid in each channel making six passes through the generator, a single tube to each pass. This is accomplished by means of the six tube inlet connections 28, the thirty removable U-bend connections 14, and the six removable outlet connections 29.

It is a particular advantage of the construction of my invention that all or any of these tube connections may be removed without dismantling the shell of the generator for cleaning or to permit a different arrangement of passes. For example, as shown in Fig. 6, the U-bends 14, inlet connections 28, and outlet connections 29 may be so arranged as to provide only two passes per channel while retaining one tube per pass or, as shown in Fig. 7, headers 34 may be employed giving two passes per channel, but employing a plurality of tubes per pass. It is clear that a number of other variations may be made on these connections without departing from the scope of my invention and, indeed, by making use of one of its most desirable features.

Examiner's Statement

This is an appeal from the final rejection of claims 1 to 8, all the claims now in the case.

The appealed claims read as follows:

[See complaint supra pp. 52-5.]

Applicant discloses a heat exchanger of the shell and tube type to be used as an evaporator. The tubes are secured rigidly to two tube sheets and the tube sheets are bolted to the two ends of the shell 10. The left hand tube sheet 13 is smaller than the internal diameter of the shell, and the other tube sheet 11 is bolted on the outside of flange 17, so that the tube bundle, including the tubes and tube sheets, can be withdrawn from the shell.

The tubes are bowed so that with the tube sheets bolted in place, relative expansion between tubes and casing may take place without straining the tube joints.

Return bend members 14 are clamped on the exterior sides of the tube sheets to provide fluid connections between the ends of the different tubes.

A longitudinal baffle sheet 21 is placed over the tubes, its purpose being to prevent entrainment of water in steam generated in the casing space when the apparatus is used as an evaporator. This baffle is supported on two longitudinal members 18, which are rigidly fastened to the right hand tube sheet and are held in nearly fixed relation at the left hand tube sheet. The connection is best shown in Fig. 5 and includes a stud bolt long enough to permit slight longitudinal movement of the ends of members 18 to permit of expansion relative to the casing. Other longitudinal members 18 at the bottom join the two tube sheets in a similar manner and help to rigidify the tube bundle when withdrawn.

Intermediate their ends the tubes are provided with support members 22, best shown in Fig. 3. These members are held in proper spaced relation by longitudinal rod and sleeve members 19, 20, fastened to the right hand tube sheet.

Tracks 15 running along the bottom of the shell, and on which the tube supporting structure rests are used to render the removable tube assembly readily slidable.

The following references are applied:

Price et al	1,842,945	Jan. 26, 1932
Wilson	1,737,347	Nov. 26, 1929
Sieder	2,018,037	Oct. 22, 1935
Wright	1,435,364	Nov. 14, 1922
Brown	1,856,618	May 3, 1932
Jones	1,617,119	Feb. 8, 1927

Price et al shows the combination of a casing with a removable tube assembly of a similar type.

Wilson is taken merely to show end fluid connections constituted by individual return bend connections rather than headers.

Sieder is taken to show rod and sleeve means (Fig. 4) for holding intermediate tube supports in spaced relation.

Wright shows tracks provided to permit easy sliding of a removable tube assembly.

Brown shows the two end tube sheets of a tube assembly joined by frame members connected rigidly to one tube sheet and with slight play at the other.

Jones shows the combination, with a casing and tube assembly, of a baffle placed over the tubes to prevent entrainment of liquid when the device is used as an evaporator.

The grounds of rejection are as follows:

Claims 1 and 2 are rejected as unpatentable over Price et al in view of Wilson. In Price et al, spacing means 29 and 30 maintains the tube sheets in nearly fixed spaced relation to each other, and independently of the shell and tubes as in applicant's apparatus. To substitute individual tube connections for the header boxes would require no invention in view of Wilson, Figure 1.

Claims 1 and 2 are further rejected on the ground of aggregation. A specific type of end fluid connection is recited, at the same time as a specific type of internal tube sheet spacing means. The claimed type of end fluid connection is shown in Wilson, and the claimed type of internal tube sheet spacing means in Price et al, each operating substantially as in applicant's apparatus and in the complete absence of the other.

Claim 3 is rejected as unpatentable over Price et al in view of Wilson and Sieder. This claim further aggregatively recites the rod and sleeve members constituting "additional" spacing means for the intermediate tube supports. Whether this means is supplementary to other means or not is immaterial, being shown in Sieder functioning as in applicant's device and entirely in the absence of the specific type of end fluid connection and the specific tube sheet spacing means which this claim also recites and which are likewise old as shown by the other references.

Claim 4 is rejected as unpatentable over Price et al in view of Wilson, Sieder and Wright. The citation of four references against this claim results from the fact that it aggregates several specific features constituting independent variations of the structure in the basic reference. The patent to Wright is added merely to show lack of novelty in employing track means for carrying a tube support member of a slidable tube assembly.

Claim 4 is further rejected on the ground of aggregation for reasons indicated in the rejection of the claim on several references as set forth above.

Claims 5, 6 and 7 are rejected as unpatentable over Price et al in view of Wilson and Brown. Brown shows a pair of tube sheets held in spaced relation by longitudinal support members 15, equivalent to applicant's members 18, and with the left hand tube sheet connected by pin 36, equivalent to applicant's elements 32, so that slight relative motion is permitted. Price et al, Figure 2, shows the nuts on rods 29′ so spaced that slight motion would be permitted, and in the similar case of the baffle member explicitly refers to the provision of slots to permit motion of the baffle relative to the tube sheet. In view of these disclosures, there would be no invention in particularly specifying that the tube sheet spacing members in Price et al be adapted to permit slight longitudinal motion of the tube sheet. In other respects the references are applied as in the rejection of claims 1 and 2.

Claim 8 is rejected as unpatentable over Jones, which shows lack of novelty in the combination, with a casing and tube bundle, of a baffle over the tube bundle to adapt it for operation as an evaporator. In Jones, as in applicant's device, the tube bundle is slidably removable and the baffle is supported thereon. Such details as the tube sheet spacing means and the end fluid connections, for example, pertain only to the tube bundle member of the combination and do not bring about a new manner of cooperation of the baffle with the tube bundle. They have also been shown to be old in the other references as pointed out above.

Claims 5 to 8 are further rejected on the ground of aggregation in accordance with the reasons noted above in the application of the several references, which bear out the independence of the several claimed features.

It is believed that the rejection of claims 1 to 8 was proper in view of the prior art, as shown by the references, and for the reasons stated.

Respectfully,

Examiner

Opinion Of The Board Of Appeals

This is an appeal from the action of the Primary Examiner finally rejecting claims 1 to 8.

Claim 1 will serve as illustrative:

> 1. A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof, a second tube sheet adapted to seal the other end of said shell, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.

The references relied upon by the examiner are:

Wright,	1,435,364,	Nov. 14, 1922,
Jones,	1,617,119,	Feb. 8, 1927,
Wilson,	1,737,347,	Nov. 26, 1929,
Price et al,	1,842,945,	Jan. 26, 1932,
Brown,	1,856,618,	May 3, 1932,
Sieder,	2,018,037,	Oct. 22, 1935.

The claims on appeal relate to alleged improvements in a steam generator which is in the nature of a heat exchanger comprising a shell having tube sheets closing the ends thereof and tubes uniting the sheets. Heat transfer takes place between a fluid in the tubes and another fluid in the shell. The alleged novelty resides in the various expedients employed for mounting and supporting the tubes in the shell and connecting the same together in series.

One of appellant's tube sheets is of smaller diameter than the shell and abuts inwardly against the flange at one end of the shell. The other tube sheet is of larger diameter than the shell and abuts directly against the end thereof. The tubes are of bowed form so that contraction and expansion may take place without placing any undue strain on the tube sheets or the shell. Intermediate portions of the tubes are supported by members in the nature of shelves which are spaced from one end of the device by a combination of tubes and rods acting at spacing and fixing means, respectively. Additional means extend lengthwise of the assembly at each side of the bank of tubes and provision is made for expansion and contraction of these additional means by providing clearance at one end between stud bolts and bracket elements carried by the means referred to. The ends of the various tubes are joined in series by U bends which are held in place by suitable clamping means. To facilitate insertion and removal of the tube assembly into the shell, trackways are provided along the bottom of the shell on which the inner header may slide as the bundle is moved either inward or outward.

The patent to Price et al shows a somewhat similar assembly to that here involved, except that the tubes are united at their ends by a different expedient. The tubes are bowed as in appellant's construction and intermediate supports are provided for the bowed tubes. Provision is made for expansion and contraction of the means which tie the two ends of the assembly together.

The patent to Wilson shows it old in a heat exchanger of the same general type as that here involved to connect the various tubes in series by U bends which are clamped to the tube sheets. We agree with the examiner that the use of such an expedient in place of the more common type of the Price et al patent would not amount to invention.

The patent to Brown shows means for coupling the tube sheets together with provision for contraction and expansion which is similar to that employed by appellant.

The patent to Wright shows it old to provide a track to facilitate the movement of a tube bundle into or from a shell.

The patent to Sieder shows tube supports which are held in a fixedly spaced relation by a combination of sleeves and rods similar to that employed by appellant.

The patent to Jones shows it old to provide a baffle member in an evaporator of the same general type as is here claimed.

Without discussing the claims in detail, we agree with the examiner that they involve nothing more than a mere bringing together, in a single structure, of various features which are all old in the art. It has repeatedly been held that the mere aggregation of old features, even though the assembly may produce a superior device, does not amount to invention. See, in this connection, the Supreme Court decision of Hailes v. Van Wormer, 20 Wall. 353; Stove Co. v. Kelsey, 158 F. 622; *Ex parte* Fine, 364 O. G. 511, 1927 C. D. 84, and *In re Small,* 271 O. G. 363.

The examiner's action is affirmed

Eugene Landers)
Examiner-in-Chief)
)
W. L. Redrow) Board
Examiner-in-Chief) of
) Appeals
P. P. Pierce)
Examiner-in-Chief)

July 12, 1941

Messrs. Pennie, Davis,
Marvin & Edmonds
247 Park Ave.
New York, N. Y.

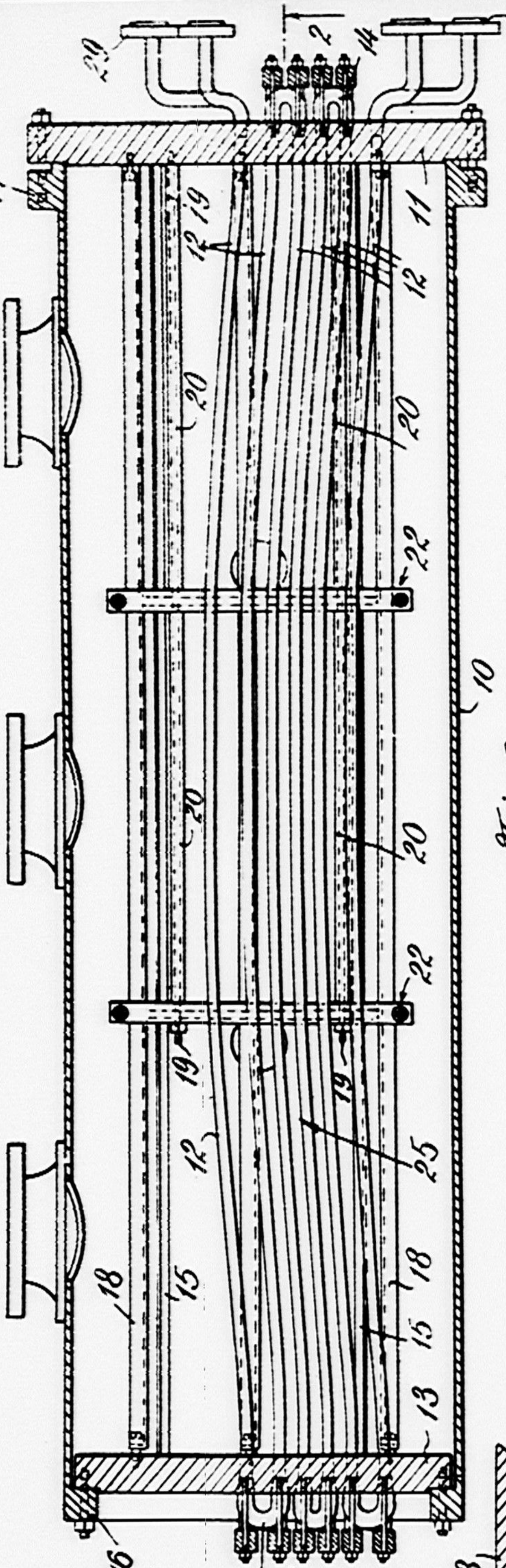
Fig. 1

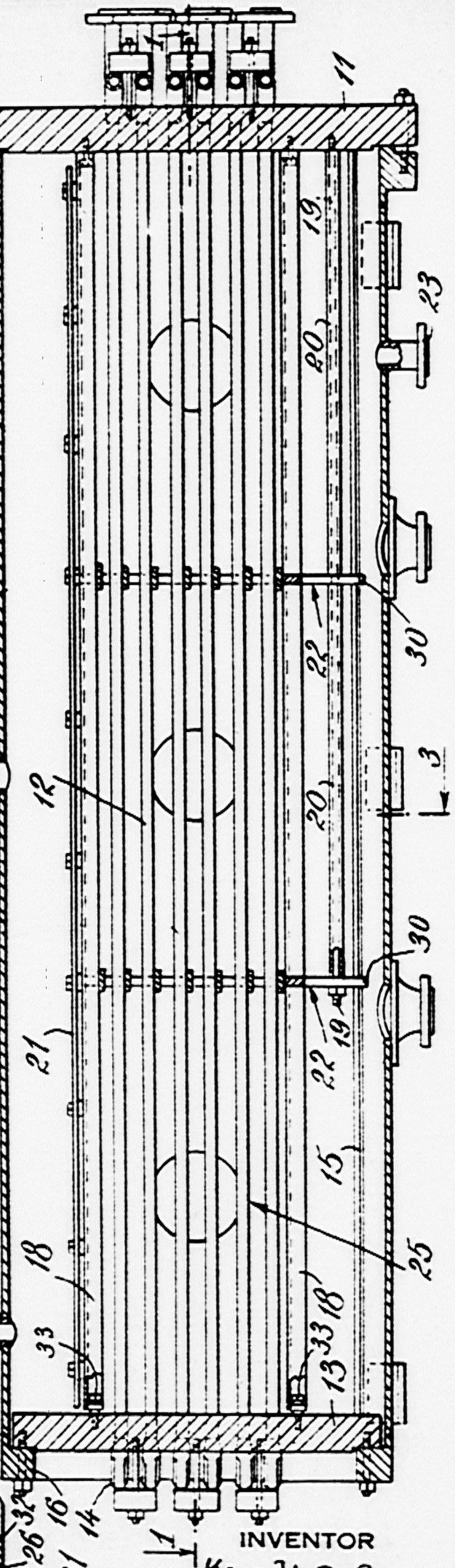
Fig. 2

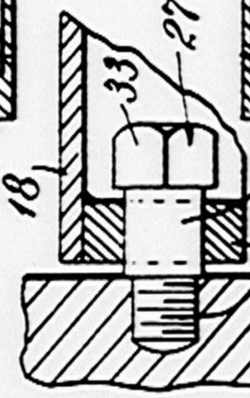
Fig. 5

INVENTOR
Kenneth B. Ris
BY
Pennie, Davis, Marvin and Edmonds
ATTORNEYS

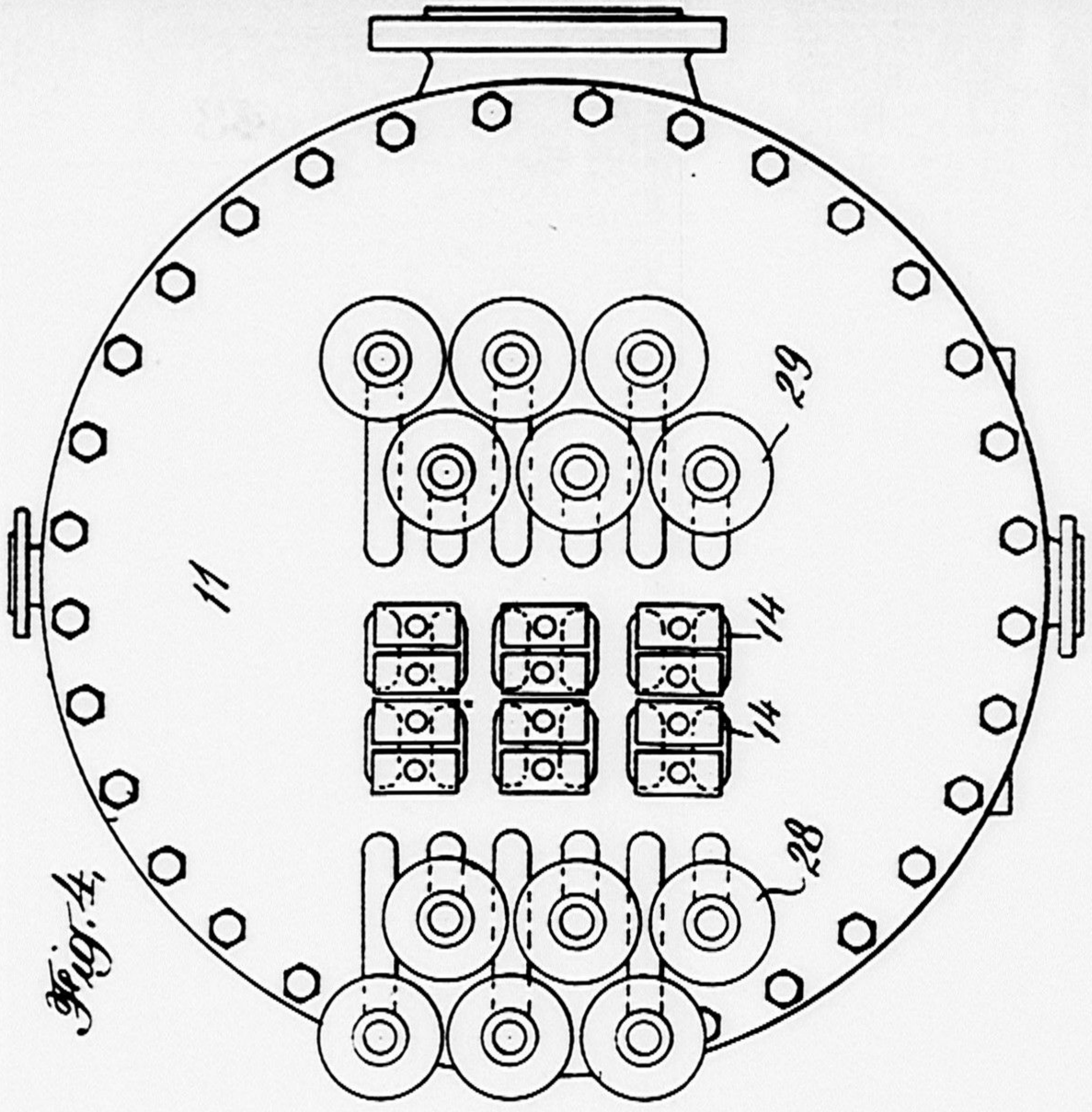
Fig. 4

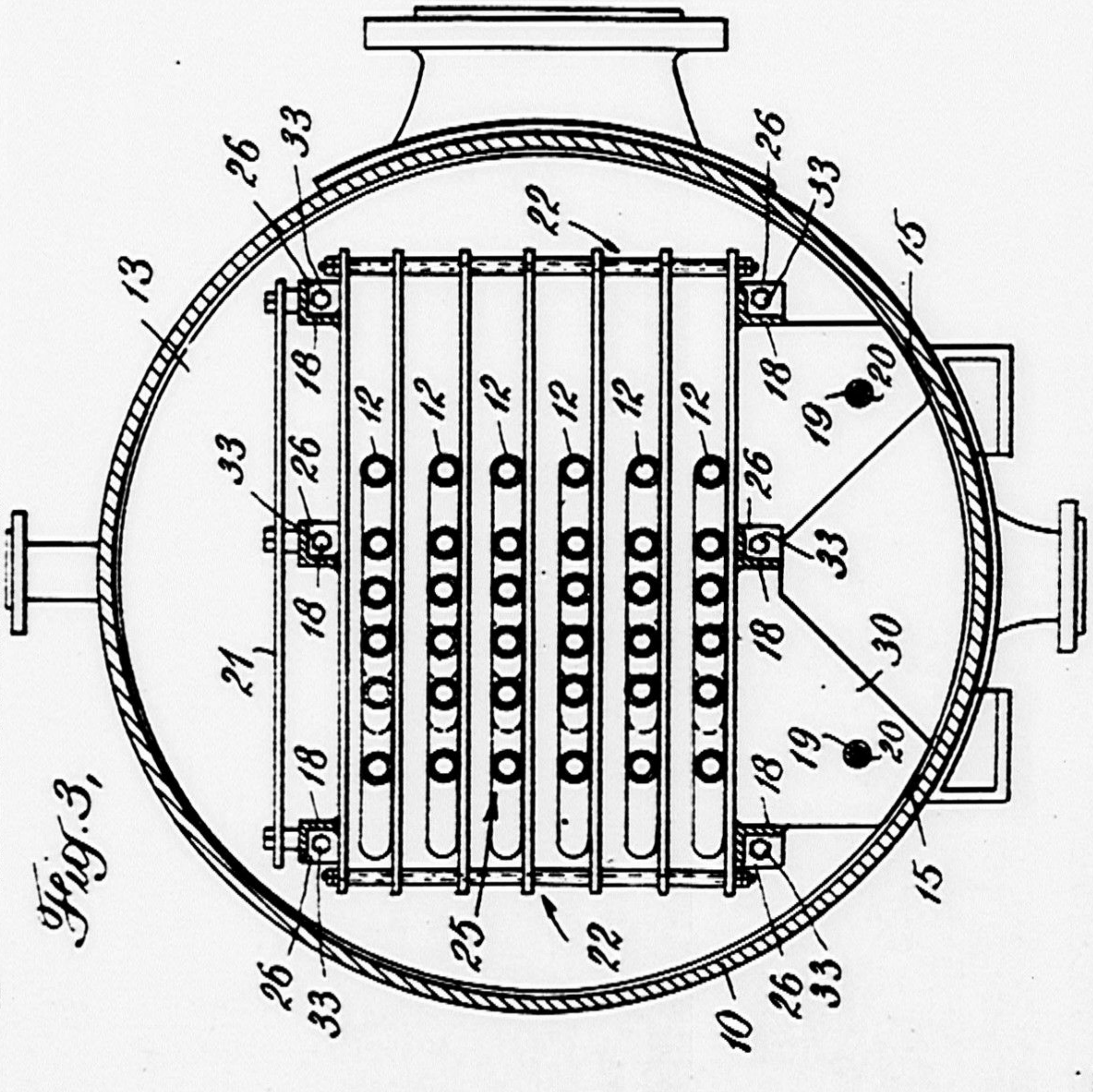
Fig. 3

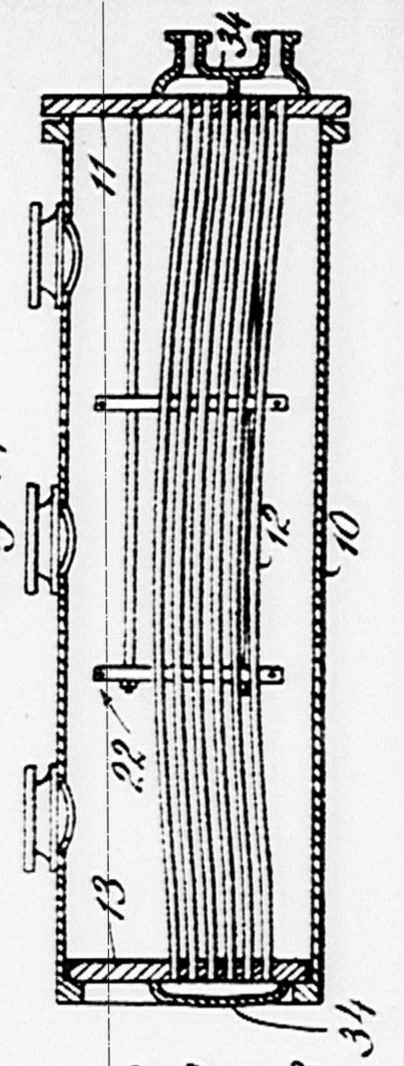
Fig. 7

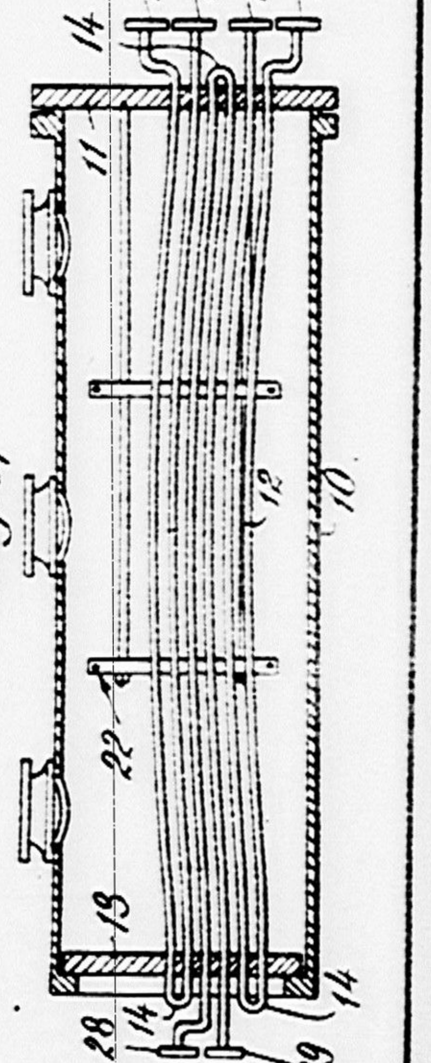
Fig. 6

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ATTORNEYS

W. M. WRIGHT.

HEATING ELEMENT SUPPORT FOR WATER HEATERS.

APPLICATION FILED APR. 21, 1921.

1,435,364. Patented Nov. 14, 1922.

Fig. 1.

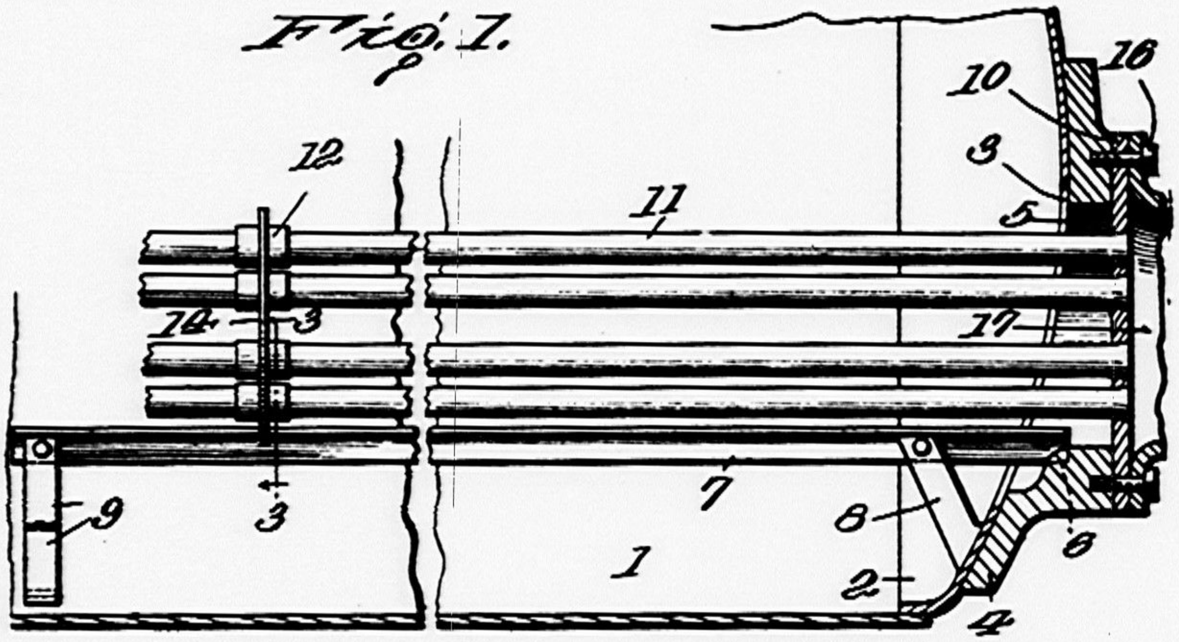


Fig. 2.

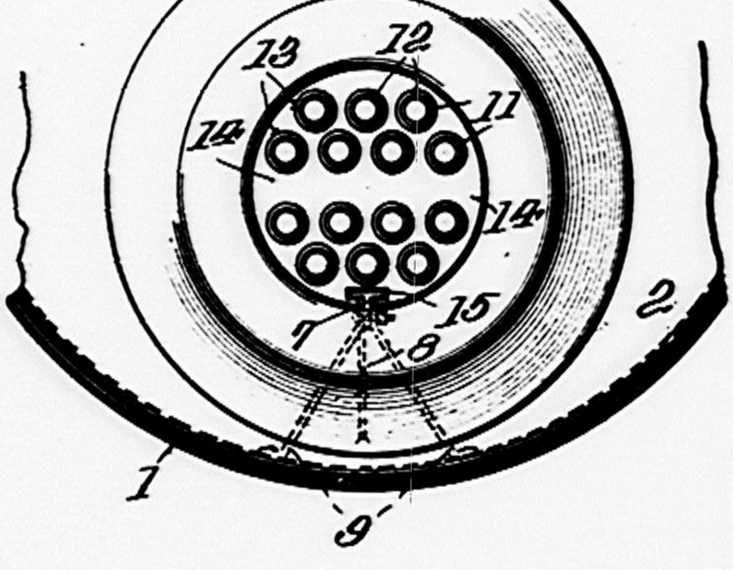
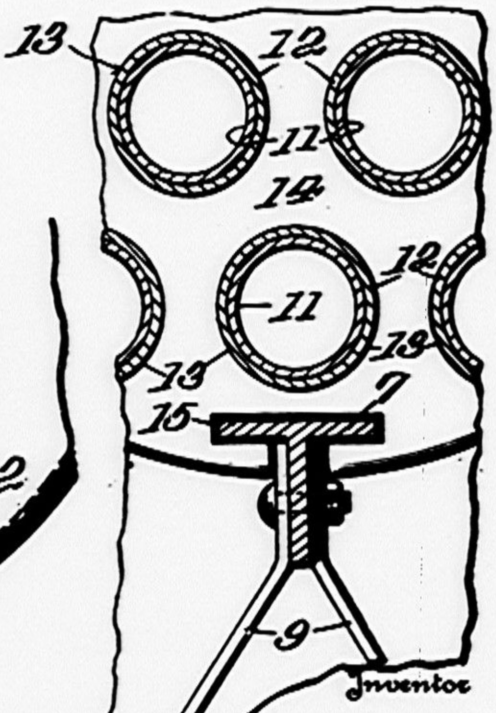


Fig. 3.



Inventor

W. M. Wright.

By

Attorney

Patented Nov. 14, 1922. **1,435,364**

UNITED STATES PATENT OFFICE

WILLIS M. WRIGHT, OF NEW HAVEN, CONNECTICUT, ASSIGNOR TO THE NATIONAL PIPE BENDING COMPANY, OF NEW HAVEN, CONNECTICUT, A CORPORATION OF CONNECTICUT.

HEATING-ELEMENT SUPPORT FOR WATER HEATERS.

Application filed April 21, 1921. Serial No. 463,104.

To all whom it may concern:

Be it known that I, WILLIS M. WRIGHT, a citizen of the United States, residing at New Haven, in the county of New Haven and State of Connecticut, have invented certain new and useful Improvements in Heating-Element Supports for Water Heaters, of which the following is a specification, reference being had therein to the accompanying drawing

This invention relates to certain new and useful improvements in heating element supports for water heaters, the object being to provide a rigid non-vibratory support for supporting the heating element within a tank in such a manner that the element as a unit can be removed for cleaning or repairing, thereby overcoming the difficulties now existing in tanks of this character by having to remove the man-hole cover and crawl into the tank to remove the braces for supporting the heating element

Another and further object of the invention is to provide a construction of support wherein the U-tubes of the heating element are arranged in copper or other metal tube sleeves disposed within a steel or iron disk so as to rigidly support the inner ends of the tubes and in such a manner that the metal tubes are supported within tubes of the same or similar metal so as to prevent any electrolytic action.

Another and further object of the invention is to provide a heating element support which is exceedingly simple and cheap in construction and one in which the heating element is slidably mounted within the tank in such a manner that when the cover of the tank is removed, the heating element can be drawn out through the opening so that the scale or any other repair necessary can be made.

Other and further objects and advantages of the invention will be hereinafter set forth and the novel features thereof will be defined in the appended claims,

In the drawings,

Figure 1 is a longitudinal vertical section through a portion of the tank, showing the application of my improved construction of heating element support;

Figure 2 is an end elevation, the tube plate being removed, showing the support and U-tubes disposed in the support plate which is slidably mounted on the T-bar; and

Figure 3 is an enlarged vertical section taken on line 3—3 of Figure 1.

In the drawings 1 indicates a tank which may be of the ordinary construction now in use having a man-hole at one end (not shown) and provided at its opposite end with a head 2 having an opening 3 over which is arranged a housing 4. The particular construction of tank is immaterial as I am aware that various constructions of tanks can be used without departing from the spirit of my invention as in some instances the shell of the tank is provided with a head having an opening and the housing as a separate element is dispensed with and therefore I do not wish to limit myself to the use of any particular construction of tank.

The housing 4 is provided with an opening 5 registering with the opening 3 of the head of the tank having a T-bar 7 horizontally disposed within the tank and supported at its forward end by a brace 8 which is bolted or welded to the stem of the T-iron 7 and has its other end rigidly secured to the head of the tank by welding or riveting the same or by welding the T-iron directly to the housing 4 when the same is made of steel.

The inner end of the T-bar 7 is supported by a brace 9, the upper end of which is secured to the stem of the T-bar by bolts or welding, the lower end being welded or riveted to the shell of the tank so as to support the T-bar rigidly in a horizontal position in a horizontal plane slightly above the lower edge of the opening 5 of the housing 4.

Secured over the housing 4 is a steel or cast iron tube plate 10 in which the ends of U-tubes 11 are expanded in the usual manner, said U-tubes extending through short lengths of copper or other metallic tube sleeves 12 which are expanded into openings 13 formed in a perforated disk 14 so that the metallic tubes 11 are in contact with short metallic tube sleeves 13 of similar metal to the tubes 11 so as to prevent any electrolytic action.

The particular construction of U-tube to form a U-bend type of heating element is immaterial and therefore I do not wish to limit myself to the particular construction of heating elements used as I am aware that under certain conditions the type of heating element can be varied without departing from the spirit of my invention.

The disk 14 is provided with a substantially T-shaped slot 15 to receive the T-iron 7 and upon which the disk is slidably mounted so that the heating element can be inserted and removed very quickly by simply removing the bolts 16 employed for holding the cover 17 and tube plate 10 to the housing. When the cover is removed, the tube plate can be withdrawn so as to remove the heating element as a unit as the supporting disk 14 slides on the T-iron 7 in such a manner that the heating element can be withdrawn through the opening 5 of the housing so as to allow the heating element to be cleaned or repaired, thereby overcoming the difficulties now existing of having to crawl in through the man-hole of tanks of this character and remove the braces so as to allow the heating element to be removed.

From the foregoing description it will be seen that I have provided a heating element support for storage and hot water heaters comprising a guide member on which is slidably mounted a supporting disk carrying the inner end of a heating element in such a manner that the heating element is free to slide inwardly and outwardly on the guide member so that the heating element can be readily inserted or removed and when in position within the tank is supported in a rigid manner by pipe sleeves arranged to receive the legs of the U-bend of the heating element.

What I claim is:—

1. The combination with a tank having an opening at one end through which is adapted to be inserted a heating element, of a guide member mounted in said tank and a heating element having a sliding and interlocking connection with said guide member.

2. A heating element support for tanks comprising a guide member, a supporting member having a sliding and interlocking connection with said guide member and a heating element carried by said supporting member.

3. A support for storage and hot water heaters comprising a heating element composed of metal tubes having a tube plate at its outer end and a supporting plate adjacent its inner end, a guide member for said supporting plate and means for supporting said heating element within said supporting plate by tube sleeves.

4. The combination with a tank having an opening at one end, of a horizontal guide member disposed within said tank and rigidly supported therein, of a heating element composed of a plurality of tubes capable of being inserted and removed through said opening and a plate for supporting said heating element having a slot corresponding in shape to said guide member and upon which said plate is slidably mounted.

5. The combination with a tank having an opening, of a heating element adapted to be inserted through said opening, a member for supporting the inner end of said heating element having an opening and a guide member disposed within said tank conforming in shape to the opening in said supporting member and upon which said member is slidably mounted.

6. The combination with a tank having an opening at one end, of a substantially T-shaped guide member disposed in said tank in a plane above the lower wall of said opening, of a supporting member having an opening corresponding in shape to said guide member slidably mounted upon said guide member and a heating element carried by said supporting member.

In testimony whereof I hereunto affix my signature.

WILLIS M. WRIGHT.

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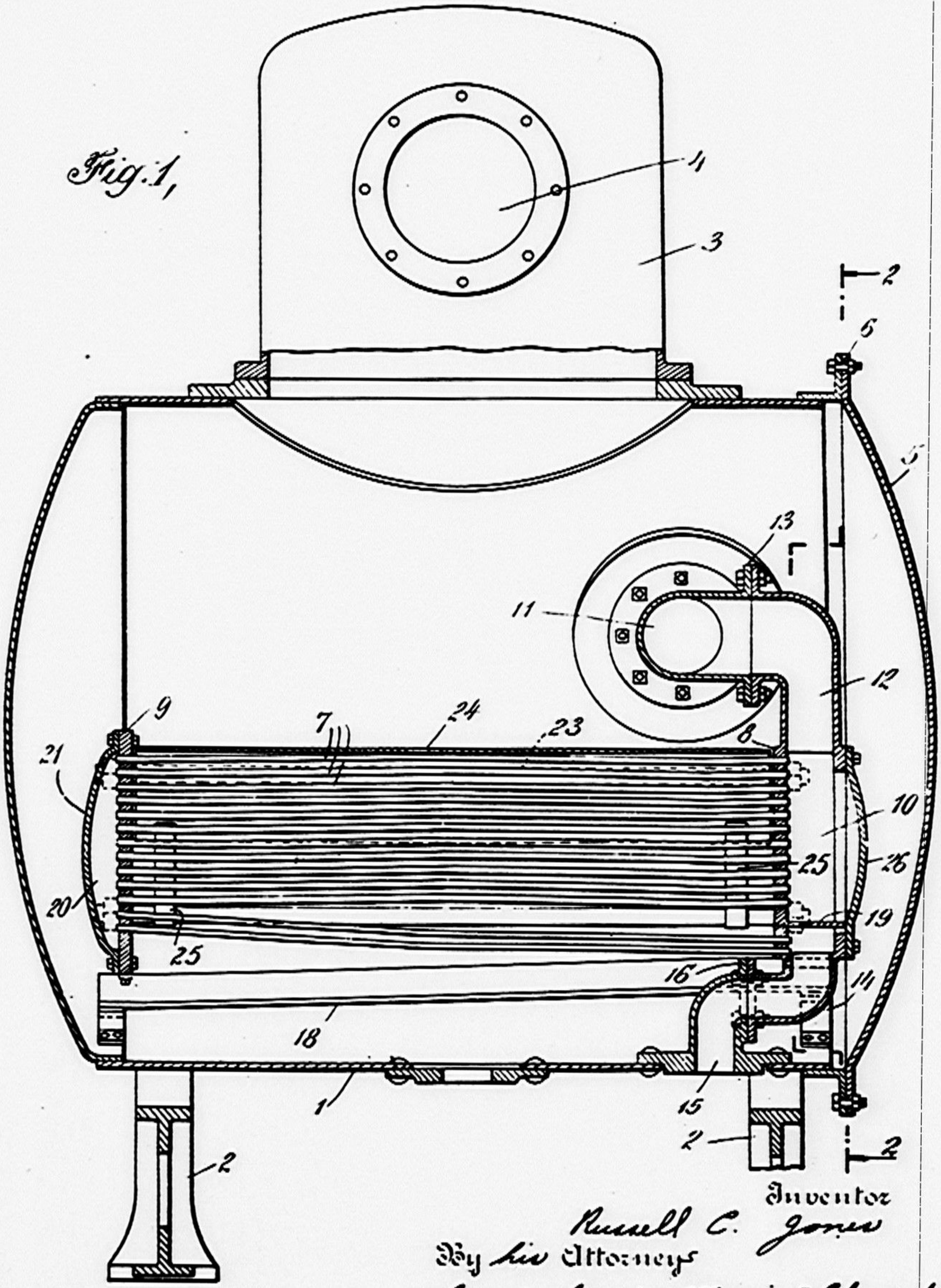
Feb. 8, 1927. R. C. JONES **1,617,119**

47

BENT TUBE EVAPORATOR

Filed Sept. 16. 1921 4 Sheets-Sheet 1

Fig. 1,



Inventor

Russell C. Jones

By his Attorneys

Pennie, Davis, Marvin, & Edmonds

Feb. 8, 1927.

R. C. JONES

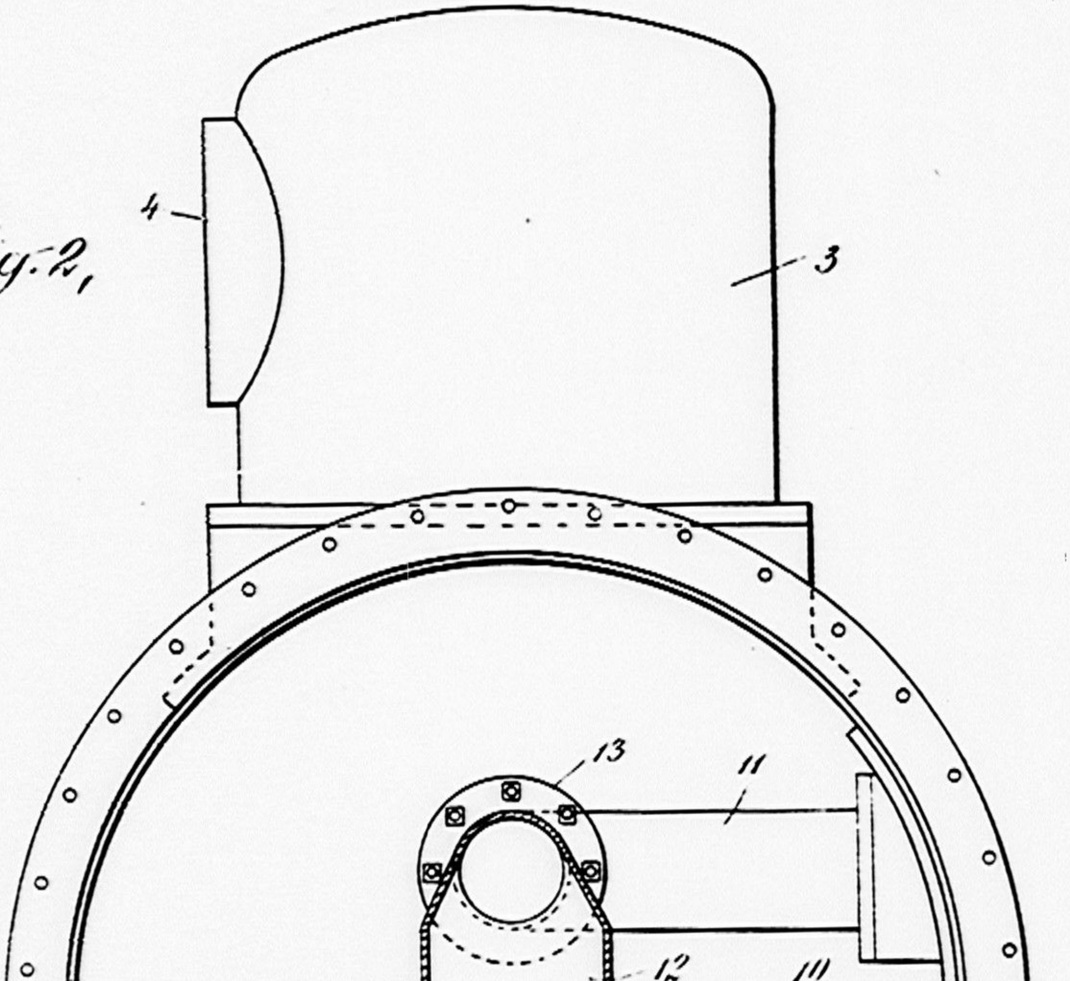
1,617,119

BENT TUBE EVAPORATOR

Filed Sept. 16. 1921

4 Sheets-Sheet 2

Fig. 2.



Inventor

By his Attorneys Russell C. Jones

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Feb. 8, 1927.

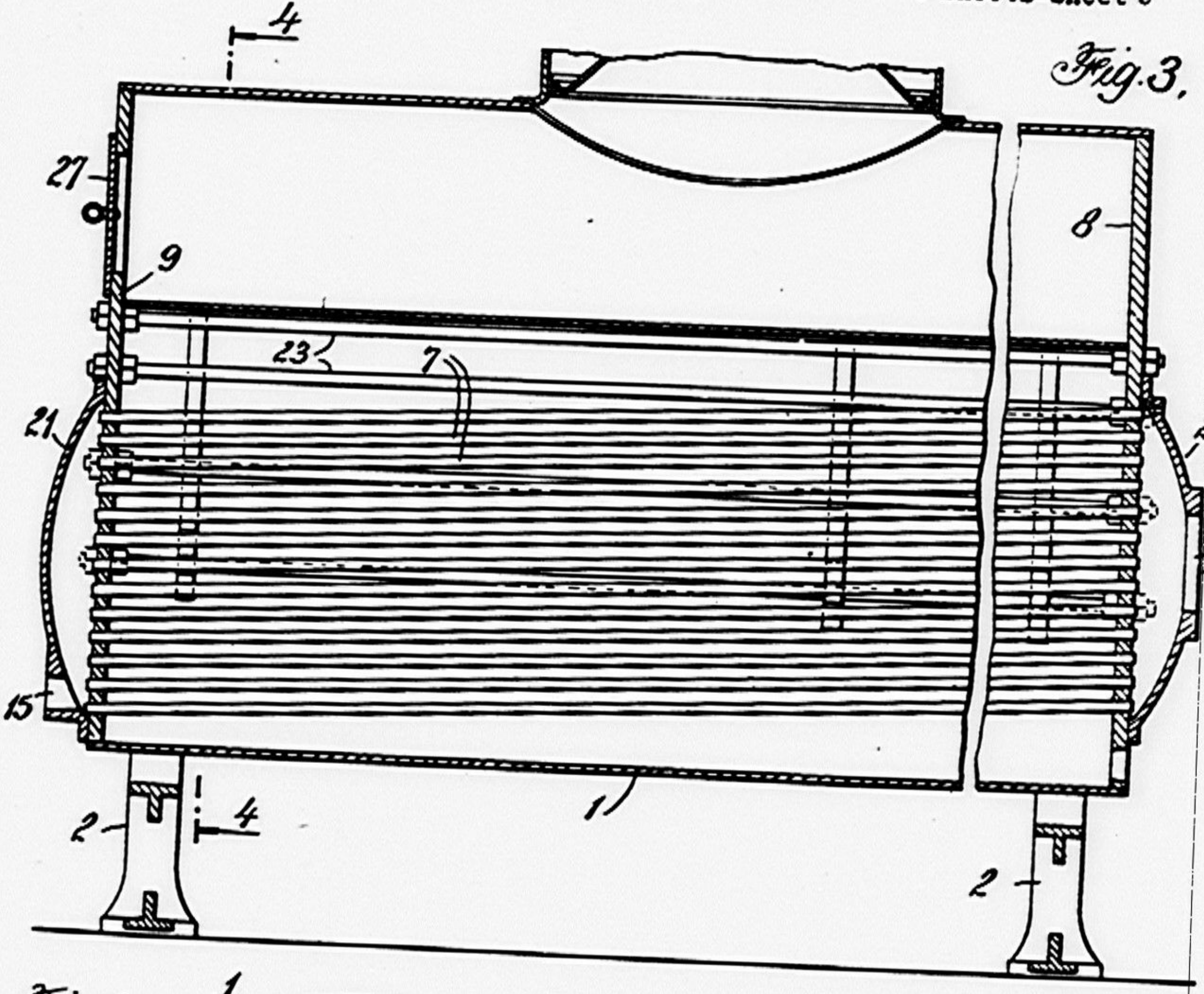
R. C. JONES

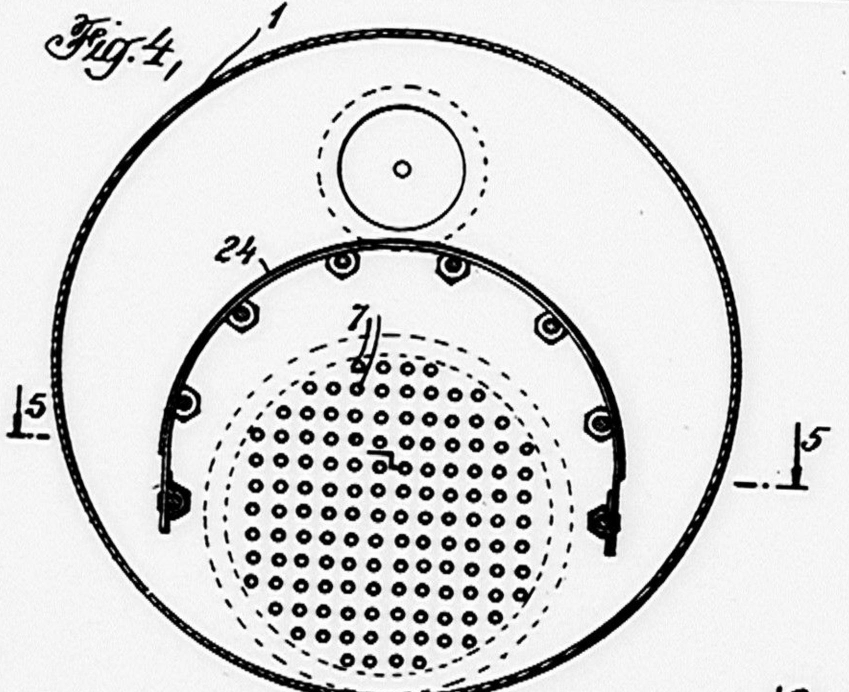
1,617,119

BENT TUBE EVAPORATOR

Filed Sept. 16. 1921

4 Sheets-Sheet 3





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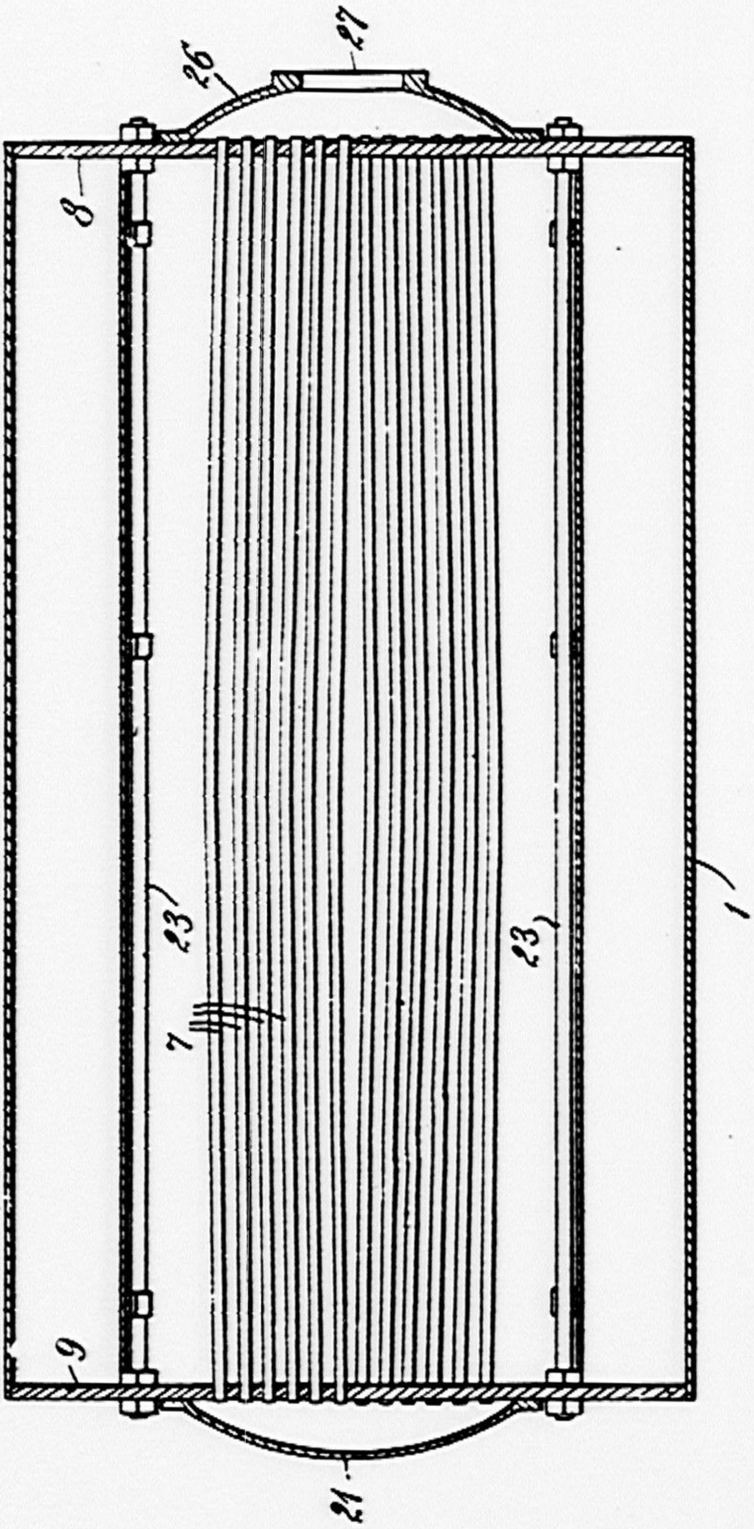
Feb. 8, 1927. 1,617,119 50

R. C. JONES

BENT TUBE EVAPORATOR

Filed Sept. 16. 1921 4 Sheets-Sheet 4

Fig. 5.



Inventor
Russell C. Jones
By his Attorneys
Pennie, Davis, Marvin & Edmonds.

Patented Feb. 8, 1927. **1,617,119**

UNITED STATES PATENT OFFICE.

RUSSELL C. JONES, OF BRONXVILLE, NEW YORK, ASSIGNOR TO THE GRISCOM RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

BENT-TUBE EVAPORATOR.

Application filed September 16, 1921. Serial No. 501,058.

This invention relates to evaporators of the kind employed principally for evaporating sea water or other impure water to obtain pure water for boiler feed or other purposes.

One of the chief difficulties with evaporators of this class is due to the fact that sea water and waters generally of such impurity that they must be distilled before use as boiler feed have marked scale-forming properties so that the surface of the heating tubes in the evaporator rapidly loses its efficiency due to accumulated scale unless the evaporator is shut down and the tubes cleaned at frequent intervals.

The principal object of my present invention is to provide an evaporator in which the tubes are self-cleaning, or substantially so, whereby the evaporators may be kept in substantially constant use with their heat-transferring surfaces at high efficiency.

A further object of the invention is to provide an evaporator of this class in which a large area of heating surface may be provided in an apparatus of moderate size, thereby increasing the vapor output in relation to the size and weight of the apparatus. This feature of the invention is of particular importance in evaporators for use on shipboard where the conservation of space is a factor of greatest importance.

A further object of the invention is to provide an evaporator which is of simple design and low manufacturing cost and which may be readily taken down for the replacement of a defective tube or other purpose.

With the above objects in view, my invention consists of the construction shown and described in the accompanying drawings, wherein—

Fig. 1 is a vertical longitudinal section of an evaporator constructed according to my invention;

Fig. 2 is a transverse section on line 2—2 of Fig. 1;

Fig. 3 is a longitudinal vertical section of a modified form of apparatus embodying my invention;

Fig. 4 is a transverse sectional view taken on line 4—4 of Fig. 3; and

Fig. 5 is a longitudinal view taken on line 5—5 of Fig. 4.

Referring to the drawings, 1 indicates the evaporator shell, here shown as of the horizontal type and supported on frames 2 at the ends thereof. The shell 1 is provided with the usual vapor dome 3 which may contain a separator of any preferred construction and from which the vapor is delivered through the outlet port 4. The front end 5 of the evaporator is detachably connected to the shell by bolts 6 in the flanges to give access to the interior of the shell and permit the withdrawal of the heating tubes, etc.

The heating surface is provided in the form of a large number of slightly bowed horizontal tubes 7, the tubes being preferably arranged in a bundle as indicated in Fig. 2. The tubes are preferably arranged in horizontal and vertical rows and are supported at each end in tube sheets 8 and 9, respectively. The tube sheet 8 forms the rear wall of a manifold chamber 10 which receives the steam from the seam main 11 passing through the side wall of the shell, as shown in Fig. 2, and connected with an upper dome-like extension 12 of the manifold chamber 10. The dome 12 connects with the steam main by a flanged coupling 13 arranged to have its line of separation in a vertical plane. Also, the drain connection 14 for the tube bundle is attached to the drain line 15 of the shell by a similar flanged coupling 16, whereby when it is desired to withdraw the tube bundle it is necessary merely to detach the two flanged couplings 13 and 16 and withdraw the tube bundle through the open front end of the evaporator shell, the tube bundle being for this purpose preferably supported on inclined rails 18 attached to the bottom of the shell.

All of the tubes 7 are connected to the steam manifold 10 which is divided by a transverse partition 19 into an upper and a lower chamber, the lower chamber having an open connection with the drain line 14 as shown in Fig. 1.

At the rear end of the tube bundle all of the tubes connect with a common chamber 20 formed between the tube sheet 9 and the concave cover plate 21, the arrangement being such that all the tubes except the two bottom rows serve as condensing surfaces for the live steam from the steam main 11, while the two bottom rows serve principally as drain returns for the condensed steam which collects in the tubes of the upper division and is blown by the steam pressure into

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the chamber 20 whence it drains through the bottom tubes into the lower chamber of the manifold and thence into the drain line.

The tubes 7 are of small bore, which not only gives them a large surface in proportion to their cross sectional area, but keeps that surface active by reason of the fact that the water of condensation which would collect in the lower part of a tube of larger diameter is blown through the tube by the steam pressure. Due to the fact that this steam pressure keeps the tubes free from water of condensation, the tubes of the main steam passage may be mounted horizontally, but the return or drain tubes on the bottom must be given a slant sufficient to insure drainage by gravity. The tube sheet 9 does not form a floating head for the tube bundle as is commonly the case, but instead is connected to the manifold chamber 10 by tie-bolts 23 of sufficient strength to resist elongation under the pressure resulting from the expansion of all the tubes in the tube bundle.

My improved evaporator is self-scaling, and this I obtain by having the tubes slightly bowed in the manner shown, the bowing being somewhat exaggerated in order to be readily apparent.

In Fig. 1 I have shown the tubes bowed in vertical planes, the opposite ends of each tube being supported in the tube sheets 8 and 9 at substantially the same height, while the central portion of the tube is bowed upwardly so that liquid condensed along the length of the tube may find its way out at one end or the other under the influence of gravity alone. The tubes should be bent to just a sufficient extent to give a lateral direction to the middle of the tube when the tube is elongated through expansion, and the smaller the degree of bow within such limits as necessary to protect the tubes from rupture, the greater will be the surface distortion of the tubes for the same degree of elongation.

To increase the efficiency of the evaporator I preferably cover the tube bundle with an inverted U-shaped submerged baffle 24 generally similar to that employed in the multi-coil evaporator shown and described in my prior U. S. Patent No. 1,299,955, granted April 8, 1919. This baffle may conveniently be supported on the tie-rods 23 by means of stirrups 25, as shown in Fig. 2.

For facilitating the cleaning of the bores of the tubes, and for facilitating the removal of a defective tube the outer face of the manifold chamber 10 is provided with a cover plate 26 the removal of which, together with the removal of the cover plate 21, gives free access to both ends of the tubes.

Figs. 3 to 5 illustrate a modified form of apparatus embodying my invention. I have illustrated in these figures a type of evaporator in which the tube bundle is built in as an essentially integral part of the evaporator unit, in contrast to the removable tube bundle as illustrated in Figs. 1 and 2. The tube sheets 8 and 9, into which the ends of tubes 7 are secured, are extended so as to completely enclose the shell and thus constitute the end walls of the evaporator, a door 27 being provided in one of the walls affording access to the interior. The sheets 8 and 9 are held in properly spaced relation by means of tie-bolts 23 extending the length of the shell and having their ends rigidly connected to the tube sheets. A chamber head 26 having an inlet 27 is secured to tube sheet 8 and is in direct communication with the inlet ends of tubes 7. Likewise, a chamber 21 having an outlet 15 is secured to tube sheet 9 and is in direct communication with the discharge ends of tubes 7. Steam is admitted at the opening 27 into chamber 26, from whence it divides evenly among the several tubes constituting the heating element of the evaporator and is condensed therein. The condensate and any vapor which may still remain uncondensed is discharged into chamber 21 and is removed by means of outlet 15.

The tube bundle 7 may be rectangular in shape as shown in Fig. 2, or it may be approximately circular in shape, as indicated in Fig. 4, the tube ends being preferably spaced in the tube sheet at equal distances from each other to form a series of horizontal and vertical rows. I have here shown the tubes slanted somewhat from a true horizontal direction to facilitate their proper drainage. As shown in Fig. 5, the tubes of the bundle are bent in transverse planes rather than in vertical planes. All of the tubes may be bowed in the same direction, if desired, but I preferably bow alternate transverse rows in opposite directions as shown for the purpose of equalizing stresses which occur on the tube sheets 8 and 9 during expansion and contraction of the tubes and which would otherwise have to be taken up by the tie-bolts 23.

The tubes are scaled by causing a quick expansion or contraction of the tubes without a corresponding expansion or contraction of the tie-rods. This may be accomplished by filling the evaporator shell with cold water and admitting steam to the tubes, or with the hot water still in the shell the tubes may be flushed with cold water. The elongation or shortening of the tubes will produce a distortion of the tube surface which will crack and loosen the scale so that it will drop off particularly when the heating surface becomes active in the normal operation of the evaporator. The feed lines for the shell and tubes will be provided with suitable cold water connections and valves so that the scaling may be effected without

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taking the evaporator down and with only a brief interruption of the operation of the evaporator plant.

The arrangement of tubes in a horizontal bundle detachable as a unit in the manner shown in Figs. 1 and 2, is of particular advantage in cleaning the tube bores and replacing a defective tube. In fact, the tubes may be cleaned without removing the bundle from the evaporator by taking off the detachable side of the evaporator shell and the detachable head of the manifold at the end of the tube bundle. The tube bundles may also be made interchangeable so that a ready-set-up bundle may be quickly substituted for the bundle in use should more or less extensive repairs be required on the latter.

It is to be noted that I have illustrated a type of evaporator shell in which the tube bundle is provided as a removable unit and also a type of evaporator in which the tubes are built in to the evaporator walls and must be removed individually. I have further illustrated the removable tube bundle as composed of a plurality of tubes bent in vertical planes, but it is obvious that the tubes of this bundle may equally well be bent in horizontal planes. Likewise, alternate horizontal rows may be bent in alternate directions similar to the construction shown in Fig. 5 or alternate vertical rows of tubes may be bent oppositely, provided sufficient slant be given those tubes which are bowed downwardly so that water of condensation may drain freely from the tubes under the influence of gravity alone. Likewise, the type of evaporator employing a built in tube bundle is not confined to the tube construction shown, but may embody a tube bundle in which the tubes are bowed in vertical planes, or in any other desired manner. That is, my invention resides broadly in an evaporator equipped with a tube bundle in which the individual tubes are slightly bowed out of a straight line connecting their ends, the exact manner and direction of bowing as well as the slant imparted to the tubes or the type of individual shell employed being dependent upon conditions affecting each particular installation.

In the accompanying drawings and foregoing description I have disclosed my improved evaporator as of the horizontal type but it will, of course, be understood that the improvements may be applied to other types of evaporators and that the details of construction may be variously modified without departing from the spirit of the invention.

I claim:

1. In an evaporator, the combination of a shell for the liquid to be evaporated having a detachable portion at one end to give access to its interior, a series of heating tubes therein arranged horizontally of the shell and positioned in substantial parallelism, tube sheets in which the opposite ends of said tubes are supported, said tubes and tube sheets forming a unitary tube bundle, an inlet passage at one end of said tube bundle connecting with a large portion of said tubes, a chamber at the other end of said bundle in communication with all of said tubes, and a discharge passage adjacent said inlet passage communicating with those tubes not in communication with said inlet passage, an intake passage provided on said shell for conveying heating fluid to the tube bundle, a discharge passage on said shell for receiving fluid discharged from the tube bundle and detachable connections between the respective inlet and discharge connections on the shell and the inlet and discharge passages carried by the tube bundle, the fluid passage at said detachable connection suffering no change in dimensions or direction.

2. An evaporator for producing purified vapor from liquid containing scale forming impurities comprising a shell for containing the liquid to be evaporated, a heating element at least partly submerged in said liquid and comprising a series of tubes, tube sheets in which the ends of said tubes are supported, said tubes being slightly bowed, and tie bolts extending between said tube sheets for maintaining said tube sheets against free relative movement under the expansion and contraction of said tubes, whereby changes in temperature of the heating tubes will cause an appreciable bending or straightening of the tube to thereby exfoliate the scaly deposit of impurities accumulated on said tubes.

3. An evaporator for producing purified vapor from liquid containing scale forming impurities comprising a shell for containing the liquid, a heating element extending into said liquid and comprising a series of tubes of small bore grouped together in a tube bundle in substantial parallelism along their entire length, a portion of said tubes being slightly bowed in one direction away from a straight axial line, a second portion of said tubes being bowed in another direction away from parallelism with said line, and means independent of said shell for supporting the ends of said tubes and maintaining the ends of the tubes against free relative movement under the expansion and contraction of said tubes, whereby changes in temperature will produce an appreciable flexure along a substantial portion of the length of each tube and thereby exfoliate accumulated scale.

4. In an apparatus for heating and treating water involving the deposit of scale-forming substances from the water, the combination of a vessel, a heating element therein comprising a plurality of heat-transferring tubes arranged in substantial parallel-

ism, tube sheets supporting the ends of said tubes, means independent of said shell for maintaining said tube sheets against separation through the expansion of said tubes, said tubes being slightly bowed out of a straight line, whereby relatively small elongation of the tubes through heat expansion produces a relatively large deformation of the metal of the tube and thereby exerts a loosening action on the deposited scale.

5. In an apparatus for heating and treating liquids involving the deposit of scale-forming materials, the combination of a vessel, a heating element therein consisting of a plurality of heat-transferring tubes arranged in substantial parallelism, said tubes being slightly offset at their middle portions, the extent of such offset being just sufficient for elongation of the tube through heat expansion to produce a further bowing of the tube instead of rupturing it, and means independent of said vessel for holding said tube sheets against the thrust occasioned by the elongation of said tubes.

6. In an evaporator, the combination of a shell for the liquid to be evaporated having a detachable portion at one end to give access to its interior, a removable heating element comprising a pair of tube sheets having a plurality of heating tubes extending therebetween, said tubes being arranged in substantial parallelism along their entire length, and means forming a part of said removable heating element for maintaining said tube sheets against free relative movement under the expansion and contraction of said tubes, said tubes being bowed away from a straight axial line sufficiently to prevent rupture but not sufficiently to prevent a substantial exfoliation of the scaly deposit of impurities accumulated on the tubes by bending or straightening of the tubes under change in temperature.

7. In an apparatus for heating and treating water involving the deposit of scale-forming substances from the water, the combination of a vessel, a heating element therein comprising a plurality of heat transferring tubes arranged in substantial parallelism, tube sheets supporting the ends of said tubes, said tubes and tube sheets being removable as a unit from the vessel, and means forming a part of said removable unit for maintaining said tube sheets against separation through the expansion of said tubes, said tubes being slightly bowed out of a straight line whereby relatively small elongation of the tubes through heat expansion produces a relatively large deformation of the metal of the tube and thereby exerts a loosening action upon the deposited scale.

8. In an apparatus for heating and treating liquids involving the deposit of scale-forming materials, the combination of a vessel, a removable heating element therein consisting of a plurality of heat transferring tubes arranged in substantial parallelism, said tubes being slightly offset at their middle portions, the extent of such offset being just sufficient for elongation of the tubes through heat expansion to produce a further bowing of a tube instead of rupturing it, and means forming a part of said removable heating element for holding said tube sheets against the thrust occasioned by the elongation of said tubes.

9. In an evaporator, the combination of a shell for the liquid to be evaporated having a detachable portion at one end to give access to its interior, a removable heating element comprising a plurality of heating tubes positioned in substantial parallelism, tube sheets in which the opposite ends of the tubes are supported, a header associated with the front tube sheet having inlet and outlet joint surfaces at right angles to the axis of the heating element, said inlet communicating with a large portion of said tubes and said outlet communicating with those tubes not in communication with said inlet, and a chamber at the other end of the removable heating unit in communication with all of said tubes, an intake passage provided on said shell for conveying heating fluid to the apparatus, a discharge passage on the shell for receiving fluid discharged from the apparatus, detachable connections between the respective intake and discharge passages on the shell and the inlet and outlet of the heating element header, a pair of rails within the shell upon which the heating element is slidable to and from its operative position, said detachable connections having joint surfaces positioned in horizontal alignment with the joint surfaces on the heating element header when the heating element is supported on said rails, and the planes of the joint surfaces of said detachable connections being disposed so as to contact with the joint surfaces of the header when the heating element is slid into its operative position within the shell.

In testimony whereof I affix my signature.

RUSSELL C. JONES.

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Nov. 26, 1929. R. E. WILSON 1,737,347

HEAT EXCHANGER

Filed Jan. 22, 1927 4 Sheets-Sheet 1

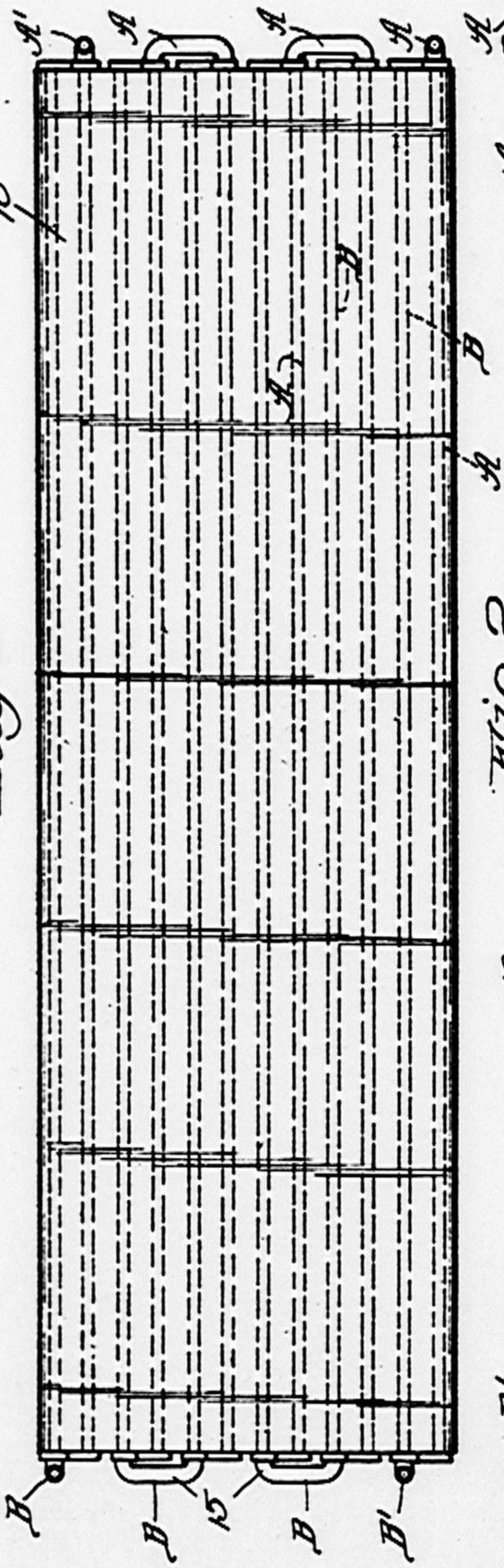

Fig. 1.

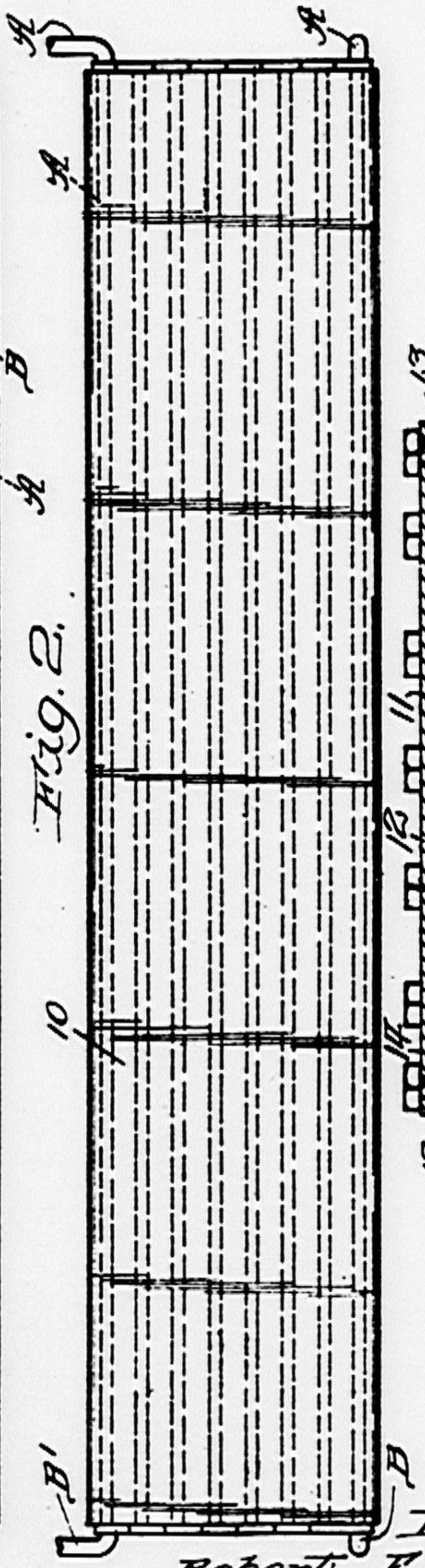

Fig. 2.

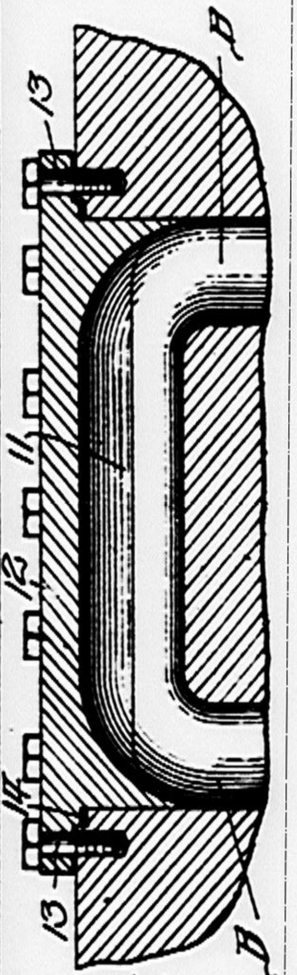

Fig. 4.

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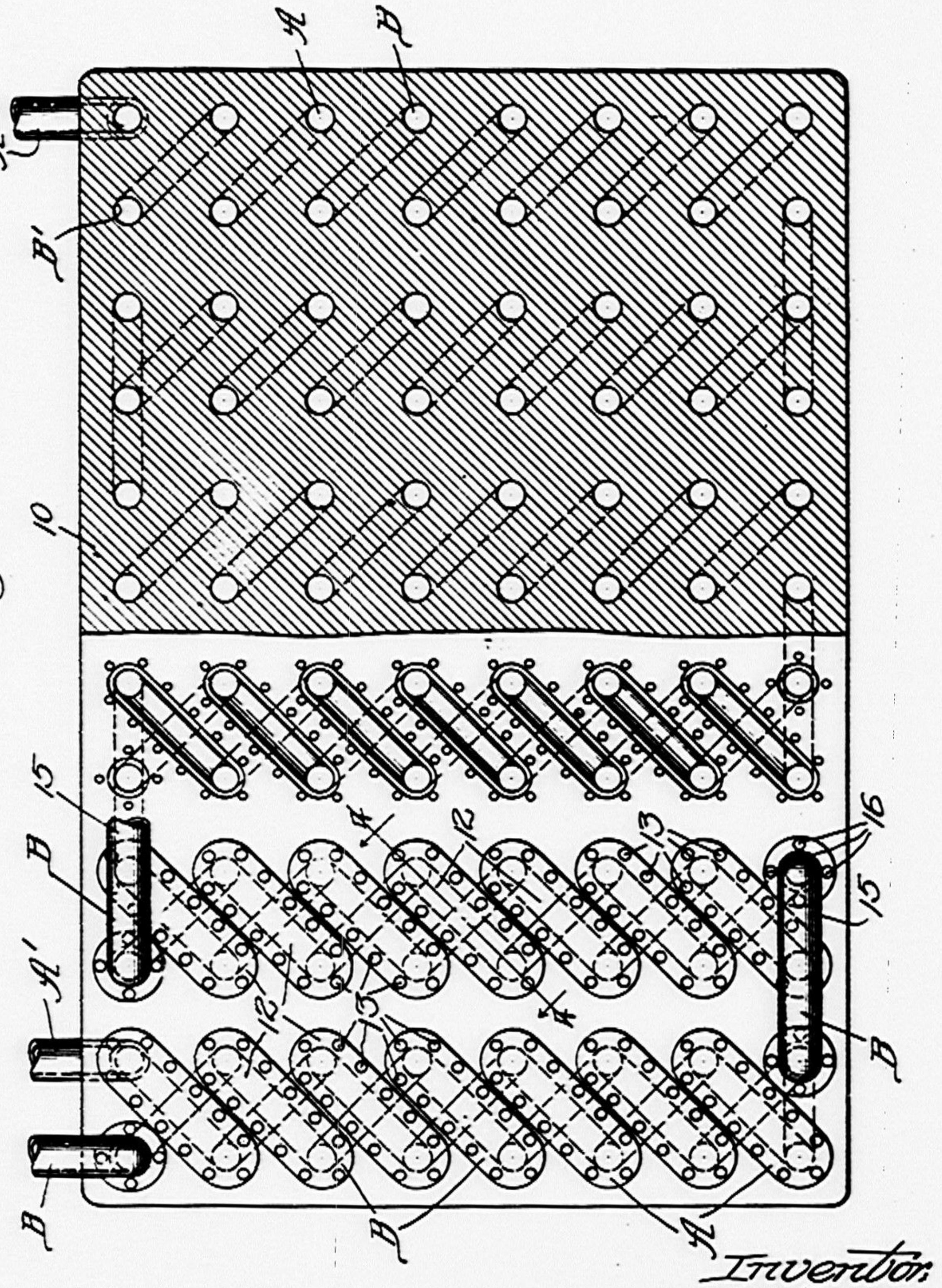
Nov. 26, 1929. R. E. WILSON 1,737,347 56

HEAT EXCHANGER

Filed Jan. 22, 1927 4 Sheets-Sheet 2

Fig. 3



Inventor:
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Nov. 26, 1929. **R. E. WILSON** **1,737,347**

HEAT EXCHANGER

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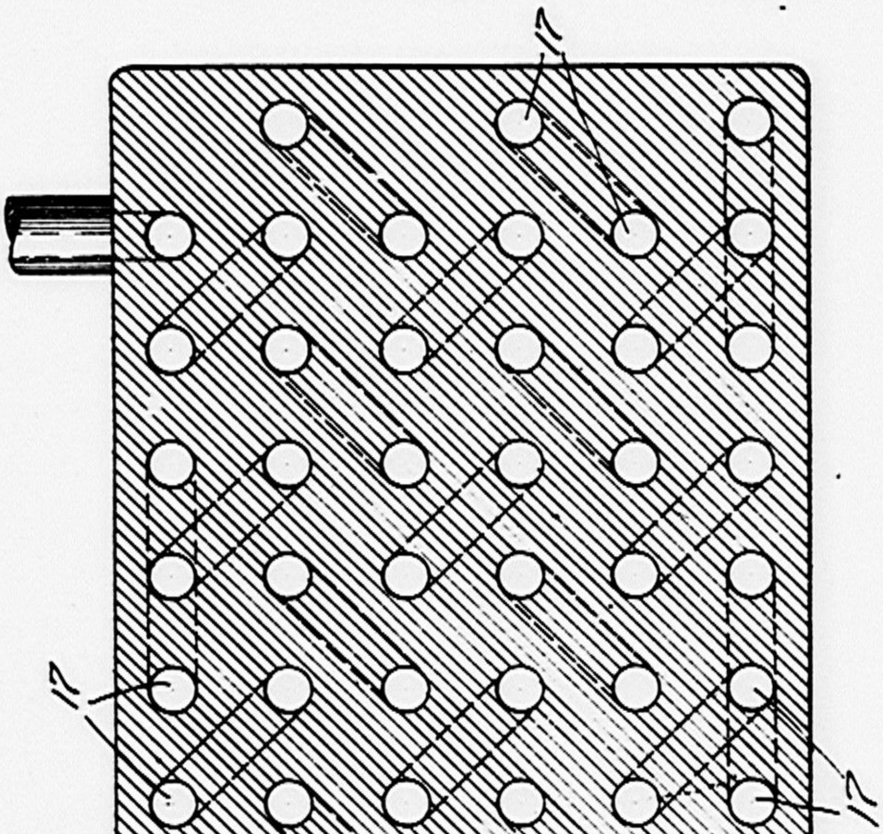

Fig. 5

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HEAT EXCHANGER

Filed Jan. 22, 1927 4 Sheets-Sheet 4

Fig. 8.

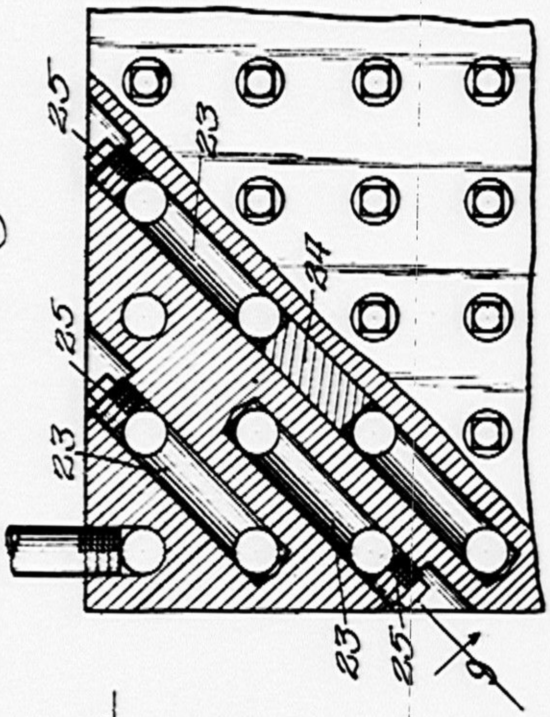
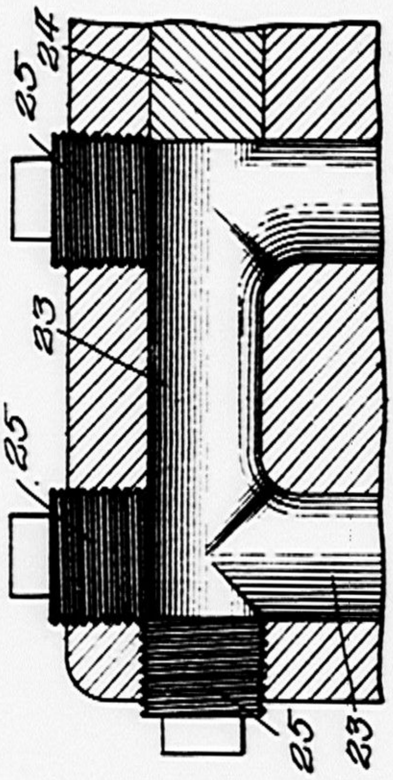


Fig. 9.



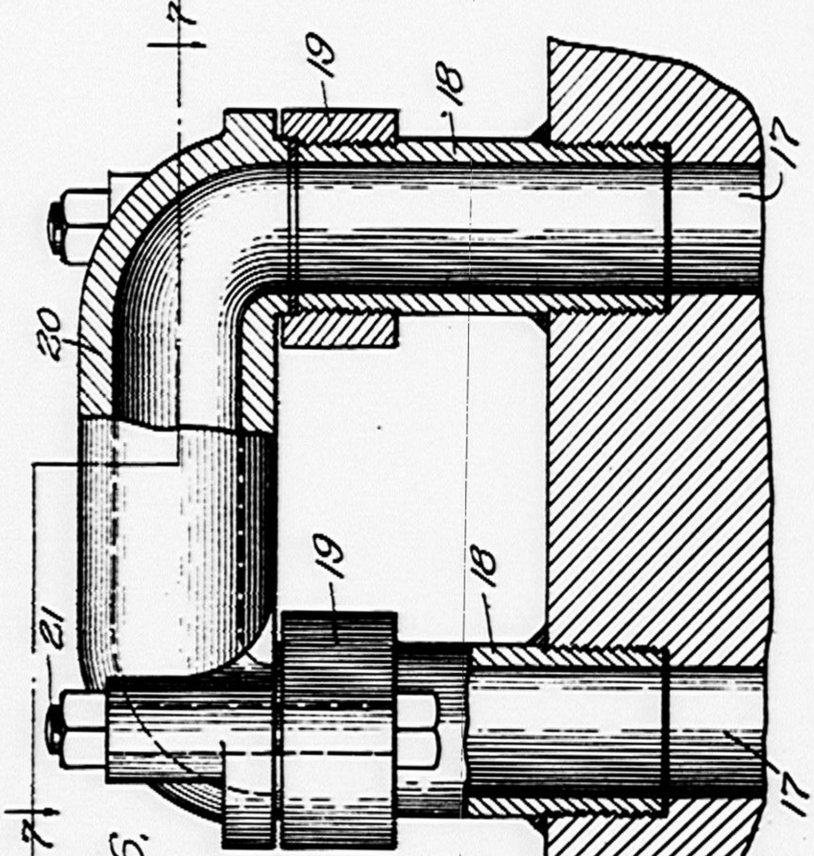
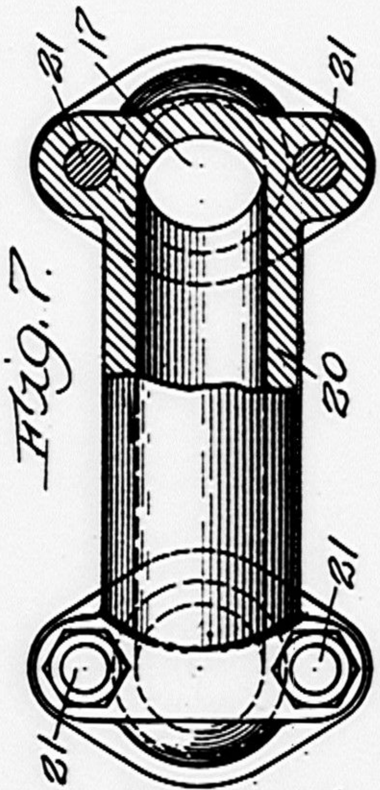


Fig. 6.

Fig. 7.



Inventor
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Patented Nov. 26, 1929 **1,737,347**

UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

REISSUED

Application filed January 22, 1927. Serial No. 162,740.

This invention relates to improvements in heat exchangers and more especially to such an exchanger adapted for exchanging, transferring, or conducting heat from one fluid to another under such conditions that accessibility and ease of cleaning are important, and where the pressures may be high.

For example, in the treating of oils, it frequently is necessary to heat one oil and cool another at the same time. Obviously, this can be done with the greatest efficiency by transferring the heat from the oil to be cooled to the one to be heated. One of the objects of my invention is to accomplish this transfer of heat with the slightest loss possible.

Although I show and describe a device especially adapted for the use of oil in both circulatory systems, it is to be understood that any other fluids may be used, without detracting from the spirit of my invention.

In devices of this character, it is frequently necessary or desirable to clean the circulatory systems of the two fluids. For example, in the cooling or heating of either of the fluids there is often deposited a film or coating of substance that eventually interferes with the conduction of heat unless the same is removed. If the circulatory systems are tubular and composed of straight lengths of tubes, the ends of which can be opened, the cleaning is rather easily accomplished. In many heat exchangers heretofore used, however, although one of such systems was tubular the other in most cases was not. One of the features of my invention is to make both systems tubular. That is, the systems carrying the oil to be cooled and the oil to be heated are both tubular. Each system is also composed of straight lengths, the ends of which can be opened in order to permit the ready insertion and operation of well known brushes and cleaning tools.

Another feature of my invention, besides providing two tubular circulatory systems, is the provision of a continuous or solid metal conductor between such systems. It is well known that metal is a very good conductor of heat; and I have produced great efficiency in my improved device by using solid or continuous metal as a conductor between the two systems, without the interposition of any other medium. This also makes it possible to operate at high pressures.

Other features and advantages of my invention will appear more fully as I proceed with my specification.

In that form of device embodying the features of my invention shown in the accompanying drawings, Fig. 1 is a top plan view of my improved heat exchanger, Fig. 2 is a similar view in side elevation, Fig. 3 is a view partly in end elevation and partly in section, Fig. 4 is a view taken as indicated by the line 4—4 of Fig. 3, Fig. 5 is a view similar to Fig. 3 showing a modified form, Fig. 6 is a view taken as indicated by the line 6—6 of Fig. 5, Fig. 7 is a view taken as indicated by the line 7—7 of Fig. 6, Fig. 8 is a fragmentary view similar to Figs. 3 and 5, showing a modified form, and Fig. 9 is a view taken as indicated by the line 9 of Fig. 8.

As shown in the accompanying drawings, 10 indicates a solid billet, of iron, steel, or other suitable metal which contains the two circulatory systems. Each of the circulatory systems comprises a plurality of straight passes or runs of tubular holes drilled or otherwise formed through the billet. Means are provided for connecting the ends of these straight passes in order to form two complete circulatory systems, one for the cold oil and one for the hot. The straight passes are preferably connected so that each pass of hot oil is close to a pass of cold oil, and preferably the flows in the two systems are approximately counter-current. It will be seen that since the passes in each system are straight and have their ends open, these passes or tubular holes may be easily and simply cleaned when the end connections are removed. Consequently, the means for connecting the passes at the ends are made removable to permit such cleaning.

Instead of using a solid billet of iron, steel or other metal, the heat exchanger may be constructed by providing the two circulatory systems with straight passes or runs of pipes and casting a metal around them. In such construction, the metal thus em-

Jan. 26, 1932. J. PRICE ET AL 1,842,945

HEAT EXCHANGER

Filed Dec. 4, 1930 2 Sheets-Sheet 1

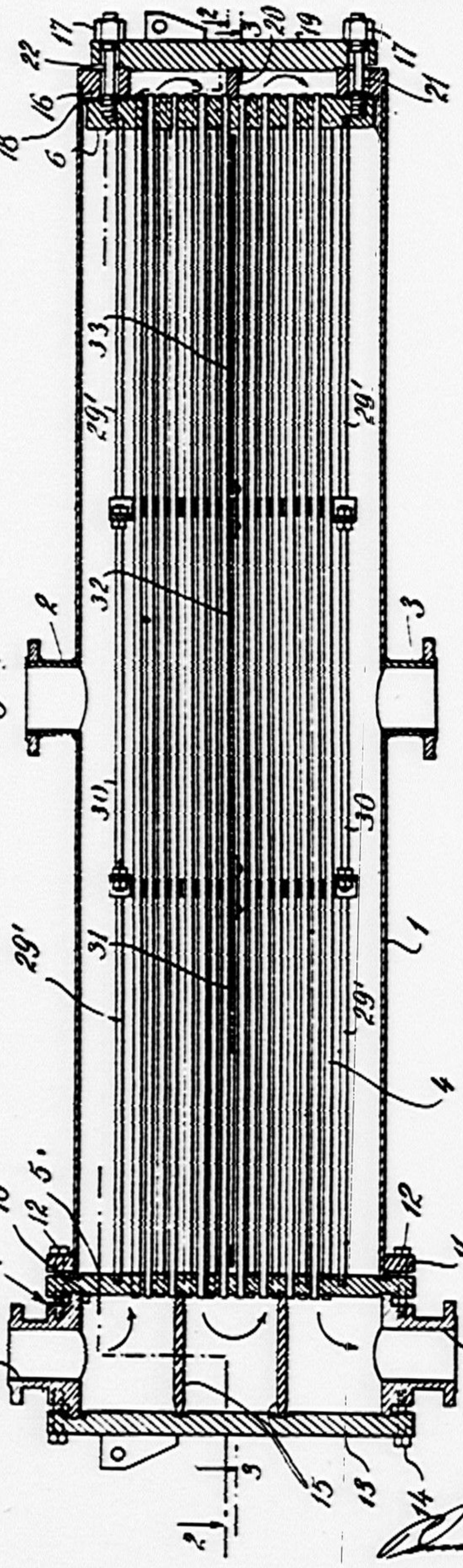

Fig. 1.

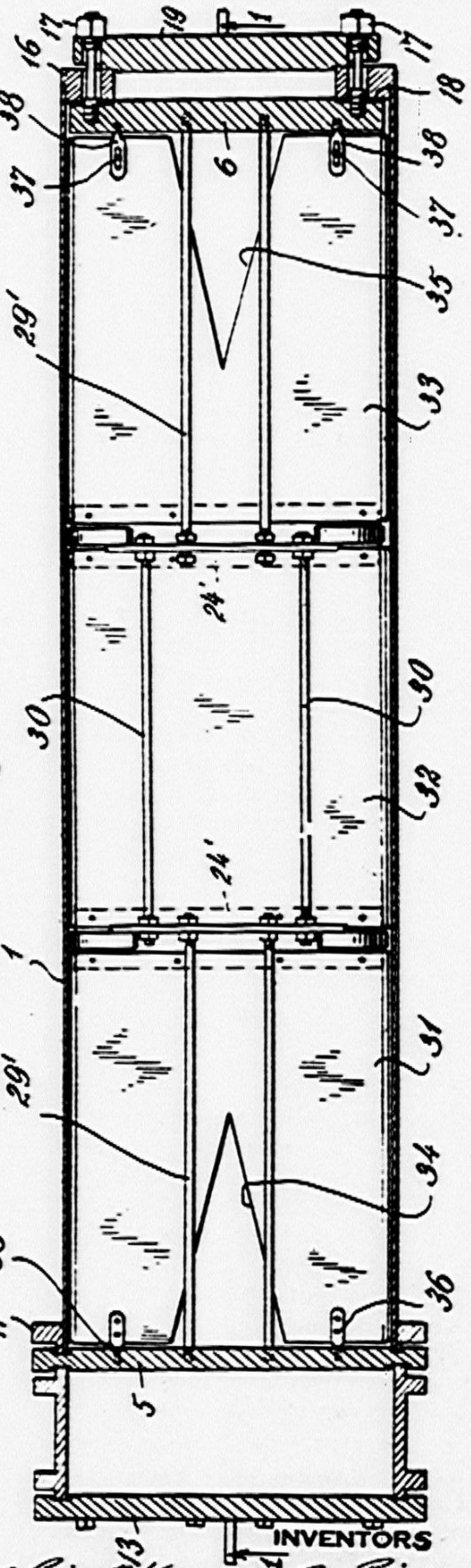

Fig. 2.

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HEAT EXCHANGER

Filed Dec. 4, 1930 2 Sheets-Sheet 2

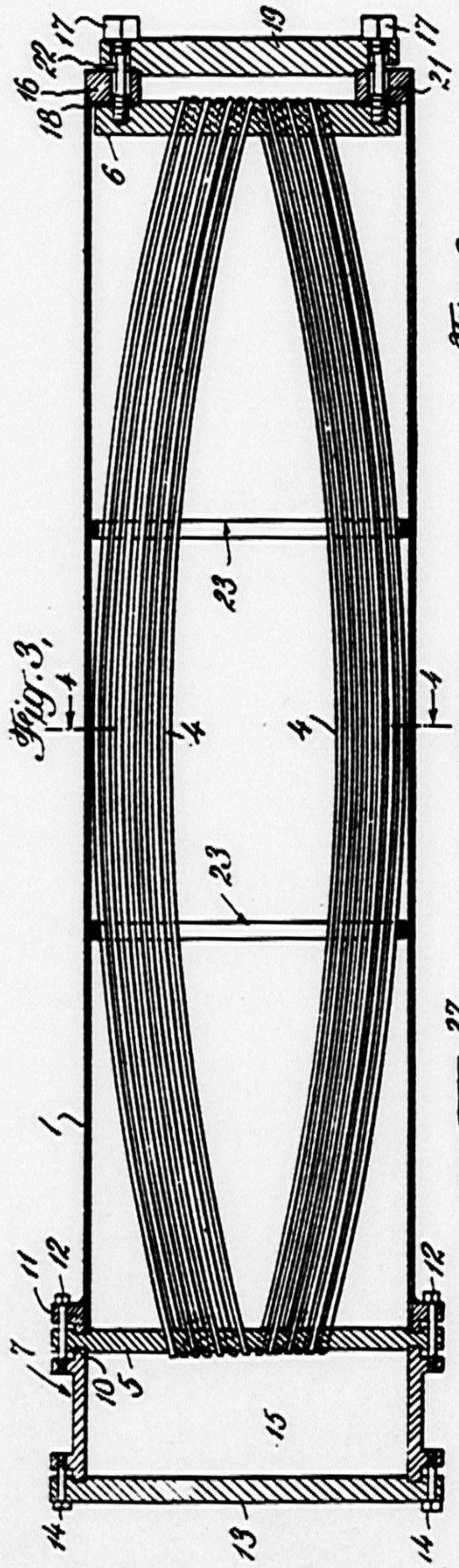

Fig. 3,

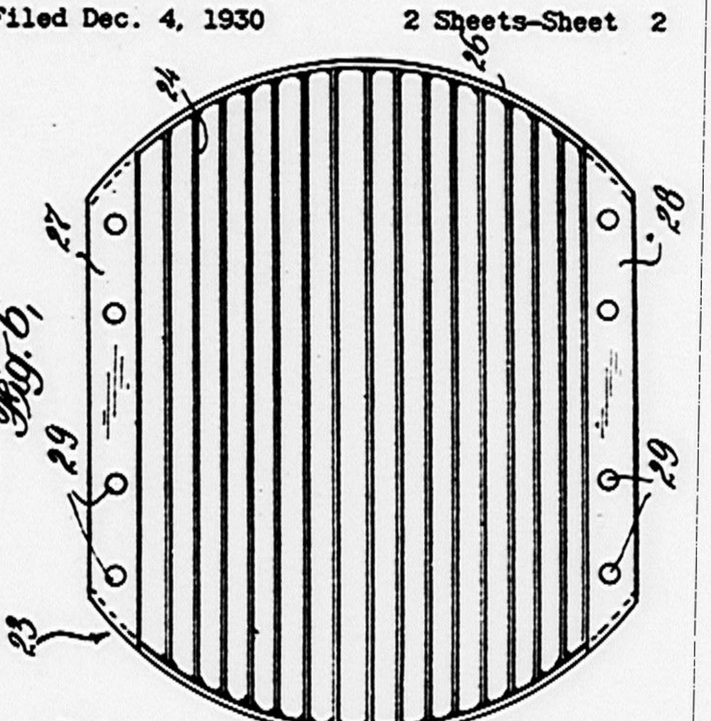

Fig. 6,

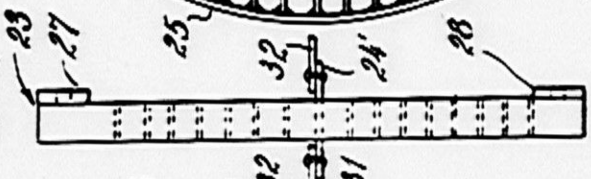

Fig. 5,

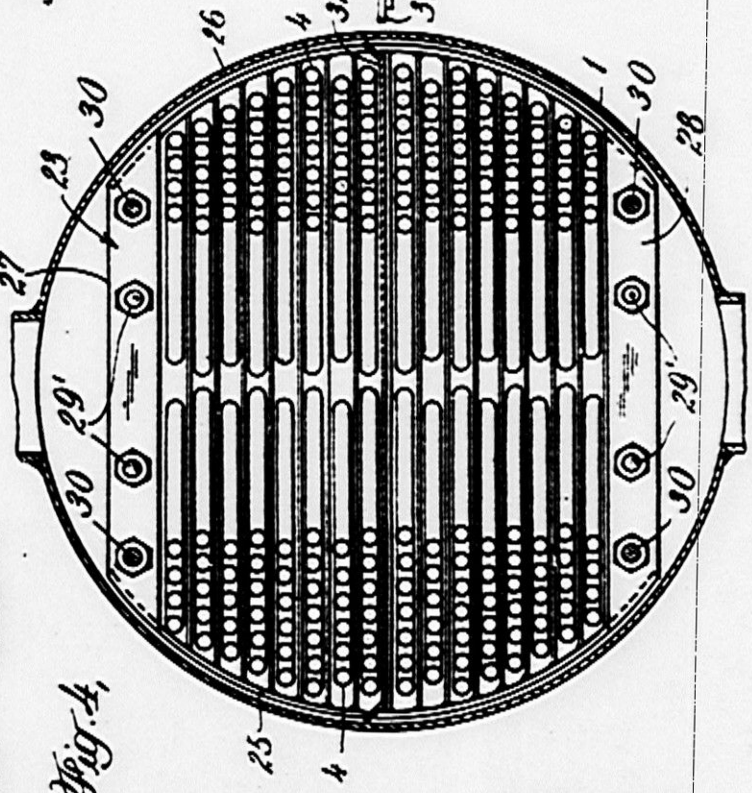

Fig. 4,

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Patented Jan. 26, 1932

1,842,945

UNITED STATES PATENT OFFICE

JOSEPH PRICE, OF WEST NEW BRIGHTON, NEW YORK, AND KENNETH B. RIS, OF DALLAS, TEXAS, ASSIGNORS TO THE GRISCOM-RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

HEAT EXCHANGER

Application filed December 4, 1930. Serial No. 499,930.

This invention relates to condensers and to heat exchangers in general, and is particularly concerned with improvements in heat exchangers of the type comprising a shell enclosing one or more bundles of tubes, the walls of which serve as a medium for conveying heat from one fluid to another. In such apparatus one fluid is caused to flow through the tubes and the other fluid is brought into heat exchanging relation with the exterior surfaces of the tubes, within the shell.

One of the objects of this invention is to provide a heat exchanger which can be manufactured at low cost and which will operate satisfactorily under varying operating conditions and which will require a minimum of attention to keep the apparatus in good working condition. With this object in view we provide apparatus including a relatively small number of inexpensive parts constructed and arranged in a manner hereinafter described whereby an efficient heat exchanger is provided which can be used for a variety of purposes with the assurance that its operation will be satisfactory under all working conditions.

In providing a heat exchanger of the type comprising a plurality of tubes enclosed within a shell, a number of problems are presented the relative importance of which depends upon the type of service for which the apparatus is designed. For example, in the petroleum industry great difficulty has been experienced with what may be termed differential tube expansion strains. In such installations the tubes may contain heavy oils, and due to different degrees of fouling, the individual tubes do not receive the same amounts of oil. Thus tubes carrying lesser amounts of oil are heated to higher temperatures, with consequent differences in tube lengths due to thermal expansions. Thus unequal expansion of the tubes produces abnormal stresses in the tube sheets, and injury may result. The relatively cold tubes may be pulled out of the tube sheets, or if this does not happen, then the relatively hot tubes may elongate to such an extent as to protrude through the tube sheet. With a view to eliminating such disastrous occurrences, our invention contemplates the provision of tubes which are adapted to accommodate unequal expansion and contraction of the tubes and to accommodate changes in length of the shell, whereby excessive stress at the ends of the tubes is entirely avoided. For example, the tubes may be bowed out of a straight line to such an extent that the distance between the ends of any given tube may change without in any way injuring the bond between the tube ends and the tube sheets. The tubes are sufficiently bowed during normal operation of the apparatus so that in the event the shell elongates more than the tubes, the tubes will merely straighten out to some extent to accommodate the change in length of the shell. On the other hand, whenever the tubes elongate more than the shell, the tubes bend slightly to increase the curvature of the tubes to an extent sufficient to compensate for the change in length and this occurs without producing any undesirable stress in the tube sheets.

By using tubes that are slightly bowed as explained above it is entirely feasible to support the ends of the tubes rigidly at the ends of the shell and our invention contemplates improved means for securing the tube sheets at the ends of the shell. This can be accomplished in such a way as to make it possible to insert the tube bundle in the shell, and remove the same from the shell whenever necessary, with a minimum of effort. Furthermore, our invention involves a method of mounting the tube sheets which greatly facilitates inspection of the apparatus to determine whether it is in proper operating condition. In general we prefer to employ an annular flange on the interior of one end of the shell, and to secure one of the tube sheets directly to this flange, a gasket being provided to insure proper sealing of the tube sheet against the flange. A cover plate may be secured to the outer face of the flange and we prefer to employ a flange of sufficient thickness to provide a tube manifold chamber between the tube sheets and the cover plate. The tube sheet and cover plate may be secured to the flange by a plurality of studs and the studs are preferably of smaller

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diameter than the stud holes in the flange whereby drip passages are provided along the studs, and these passages may communicate with an open channel formed in the cover plate. Thus any leakage of fluid through or around the gasket is readily detected and the studs may be tightened to stop the leakage, or the studs may be removed and a new gasket inserted.

Our invention may include improved means for supporting or spacing apart the tubes within the shell. Where a relatively long shell is employed, enclosing tubes of corresponding length, it is desirable to provide some means for maintaining the tubes in proper position at one or more points intermediate the ends thereof. According to our invention such spacing means are preferably connected to the tube sheets by tie rods, or the like, whereby the spacing members, the tubes and the tube sheets constitute a unitary structure which can be inserted into the shell, or removed therefrom, as the case may be, with a minimum of effort.

The various objects of our invention will be more apparent upon considering the following detailed description which is to be taken in conjunction with the accompanying drawings in which

Fig. 1 is a longitudinal sectional view of a heat exchanger embodying our invention;

Fig. 2 is a horizontal sectional view taken on line 2—2 of Fig. 1 showing details of construction;

Fig. 3 is a sectional view similar to Fig. 2 except that it is taken on line 3—3 of Fig. 1;

Fig. 4 is an enlarged transverse sectional view taken on line 4—4 of Fig. 3 showing details of construction;

Figs. 5 and 6 are, respectively, a side elevation and a front elevation of a portion of the apparatus shown in Figs. 1 to 4 inclusive.

The embodiment of our invention illustrated in the accompanying drawings comprises a heat exchanger shell 1 which may be supported in a horizontal position, or in a vertical position as may be desired. The shell 1 is provided with ports 2 and 3 for the admission and discharge of fluid to and from the interior of the shell, and the shell encloses a plurality of tubes 4 extending lengthwise thereof with the ends of the tubes suitably mounted in tube sheets 5 and 6. An annular housing 7 provided with an inlet 8 and an outlet 9 forms a manifold chamber communicating with the ends of the tubes mounted in the tube sheet 5. The housing 7 is provided with an annular flange 10 engaging a corresponding recess near the periphery of the tube sheet 5, and the housing 7 and the tube sheet 5 are both clamped firmly to the annular supporting ring or flange 11 on the exterior of the adjacent end of the shell 1. Studs 12 serve to clamp these parts together. The outer end of the housing 7 is closed by a suitable cover plate 13 which may be detachably secured to the housing by any suitable means, such as the studs 14. One or more baffles 15 may be provided within the housing to direct the flow of fluid through the apparatus as indicated by the arrows.

The tube sheet 6 at the end of the shell remote from the housing 7, is detachably secured to an annular flange 16 by any suitable means, such as the studs 17. The flange 16, carried by the shell 1, is disposed within the end of the shell and the tube sheet 6 engages the inner face of this flange, a suitable gasket 18 being interposed between these parts to provide a seal. The studs 17 may serve to hold a cover plate 19 against the outer face of the annular flange 16, and the flange 16 is preferably of sufficient width to provide a manifold chamber between the tube sheet 6 and the cover plate 19. A baffle 20 may be arranged between the cover plate 19 and the tube sheet 6 to direct the flow of fluid through the apparatus.

The annular flange 16 is provided with stud holes 21 to accommodate the studs 17, and these stud holes are substantially larger in diameter than the studs, thus forming passages extending through the flange 16. Accordingly, any fluid leaking through or around the gasket 18 from the interior of the shell is permitted to escape through the drip passages extending along the studs, and to further facilitate detections of leakage the cover plate 19 is provided with an annular recess or channel 22 in direct communication with the drip passages through the flange 16. Accordingly fluid leaking through the gasket may be at once detected in the open channel in the cover plate and the studs 17 may be tightened to stop the leakage. This attention can be given to the apparatus without the necessity for removing any shell cover, for the heads of the studs are exposed at all times.

As explained above, the tube bundle comprising the tubes 4 and the tube sheets 5 and 6, is rigidly secured at its ends to the shell 1. The tube sheet 5 is rigidly clamped against the annular ring or flange 11 and the other tube sheet 6 is clamped against the annular flange 16. Such being the construction, destructive stresses would be developed at the ends of the tubes where they are mounted in the tube sheets, unless some provision were made for making due allowance for changes in length of the shell with respect to the length of the tubes, such changes being caused by unequal expansion or contraction of the tubes and the shell. In accordance with the preferred embodiment of our invention, this is taken care of by providing tubes of such length that during normal operation they are bowed to some extent. This is best illustrated in Fig. 3 in which the bowing of the tubes has been considerably exaggerated for purposes of illustration. Where the shell is to be installed in a horizontal position the tubes are preferably initially bowed in a horizontal direction, the tubes being supported at one or more points intermediate their ends by tube supporting or spacing devices. Two such devices are shown at 23 in Figs. 1 to 4 and in greater detail in Figs. 5 and 6.

It will be understood that under some conditions, for example where relatively short tubes are employed, it is not necessary to provide any supports or spacers such as those illustrated at 23.

With respect to the feature of providing bowed tubes, it will be understood that the tubes are preferably initially bowed to such an extent that during normal operation there is sufficient "slack" in the tubes to take care of all changes in length of the shell relative to the length of the tubes and to take care of differential expansion of the tubes. The tubes are sufficiently bowed so that whenever the shell elongates more than the tubes, the tubes straighten out to some extent, but do not become perfectly straight for in such event abnormal stresses would be developed at the ends of the tubes.

The use of bowed tubes involves the use of tube sheets and a shell of such dimensions that ample space is provided for the end flange 16, and a gasket joint of satisfactory dimensions can be provided between the tube sheet 6 and the adjacent flange 16.

The tube spacers or intermediate supports illustrated at 23 each comprise a plurality of metal strips 24 secured at their ends to curved frame members 25 and 26. These frame members are interconnected by metal strips 27 and 28 each having a plurality of bolt holes 29 therein. It will be understood that the tubes pass between the strips 24 as best illustrated in Fig. 4 and are thereby maintained in proper alignment. Expansion or contraction of the tubes causes them to slide lengthwise of the strips 24 and these strips are spaced apart a distance sufficient to provide ample freedom of movement of the tubes during the expansion and contraction thereof. As illustrated in Figs. 1 and 2, tie rods 29′ serve to connect the spacer frames with the tube sheets, and similar tie rods 30 serve to interconnect adjacent spacer frames. Each set of spacer strips 24 and the supporting frame members therefor may be regarded as a cage and it will be noted that these cages are connected to the tube sheets at the extremities of the apparatus and are not fastened to the shell directly. Accordingly the cages constitute part of the unitary removable bundle comprising the tubes and tube sheets, and accordingly the spacer cages can be assembled in place on the tubes before the tube bundle is inserted in the shell.

The apparatus illustrated in the accompanying drawings includes a plurality of baffle plates 31, 32 and 33, the end baffle plates 31 and 33 having V-shaped notches 34 and 35 respectively through which fluid within the shell may pass from one section of the shell to another section thereof. The baffle plate 31 is provided with lugs 36 engaging corresponding recesses in the tube sheet 5 and the other end of this baffle plate is secured to one of the spacer strips designated as 24′ (see Fig. 5). This strip is wider than the other strips and provides a flange support for the baffle plate which is riveted or otherwise fixed thereto. In like manner the central baffle plate 32 is secured to the spacer strips 24′ of the adjacent spacer cages and the inner end of the baffle plate 33 is supported in similar manner. The outer end of baffle plate 33 is provided with projections 37 engaging slots in pins 38 carried by the tube sheet 6. This slotted connection permits relative movements of the parts which occurs whenever there is unequal expansion or contraction of the shell and the baffle plates.

It is to be understood that our invention is not limited to the details of construction of the apparatus illustrated in the accompanying drawings but includes such modifications thereof as fall within the scope of the appended claims. For example, as indicated by the appended claims, certain features of the invention may be used to advantage without employing other features which may be included in the specific embodiment of the invention herein described in detail. The construction and arrangement of the tube supporting or spacing cages may be modified and in fact the use of such devices for causing the tubes to bow in parallel planes may be eliminated if desired. The tubes can be made of material similar to that of the shell, or they may be made of metal possessing physical characteristics different from those of the shell. If the tube metal has a materially higher coefficient of expansion than the shell metal, it is merely necessary to provide a slightly larger shell to accommodate greater bowing of the tubes whenever there is a tendency for the tubes to elongate more than the shell. The arrangement of the tubes may be varied as desired, for example, alternate rows of tubes may be bowed in opposite directions, or alternate banks or passes may be bowed in opposite directions. Furthermore the construction and arrangement of the baffles within the tube manifold chambers and within the shell may be altered as desired to control the flow of fluids through the apparatus.

We claim:—

1. A heat exchanger comprising a shell, a plurality of tubes therein, a tube sheet secured to said tubes, an annular flange secured to one end of the shell and having a plurality of stud holes therein, a cover plate,

and a plurality of studs for securing the cover plate and said tube sheet to opposite sides of said flange, at least one of said studs being of smaller diameter than the corresponding flange stud hole whereby a drip passage is formed along the stud, and said cover plate having an open channel communicating with said drip passage.

2. A heat exchanger comprising a shell, a plurality of tubes therein, a tube sheet secured to said tubes, an annular flange secured to one end of said shell and having a plurality of stud holes therein, a cover plate and a plurality of studs for securing the cover plate and said tube sheet to opposite sides of said flange, said studs being of smaller diameter than the flange stud holes whereby drip passages are formed along the studs, and said cover plate having an annular open channel communicating with said drip passages.

3. A heat exchanger comprising a shell, a plurality of tubes therein, a tube sheet secured to said tubes, an annular flange secured to one end of the shell and having a plurality of stud holes therein, a cover plate, a plurality of studs for securing the cover plate and said tube sheet to opposite sides of said flange, and a gasket interposed between said tube sheet and said flange, said studs being of smaller diameter than the flange stud holes whereby drip passages are formed along the studs, and said cover plate having an open annular channel communicating with said drip passages.

4. A heat exchanger comprising a shell, a plurality of tubes therein, tube sheets to which the opposite ends of said tube are secured, a plurality of tube spacing strips, a frame for supporting said strips, and means for securing said frame to at least one of said tube sheets.

5. A heat exchanger comprising a shell, a plurality of tubes therein, tube sheets to which the opposite ends of said tubes are secured, a plurality of tube spacing strips, a frame for supporting said strips whereby the strips and frame constitute a unitary cage, means for securing said frame to at least one of said tube sheets, and a baffle supported by said cage and one of said tube sheets.

In testimony whereof we affix our signatures.

KENNETH B. RIS.
JOSEPH PRICE.

May 3, 1932. S. BROWN **1,856,618**

HEAT EXCHANGER

Filed May 23, 1930 2 Sheets-Sheet 1

Fig. 1.

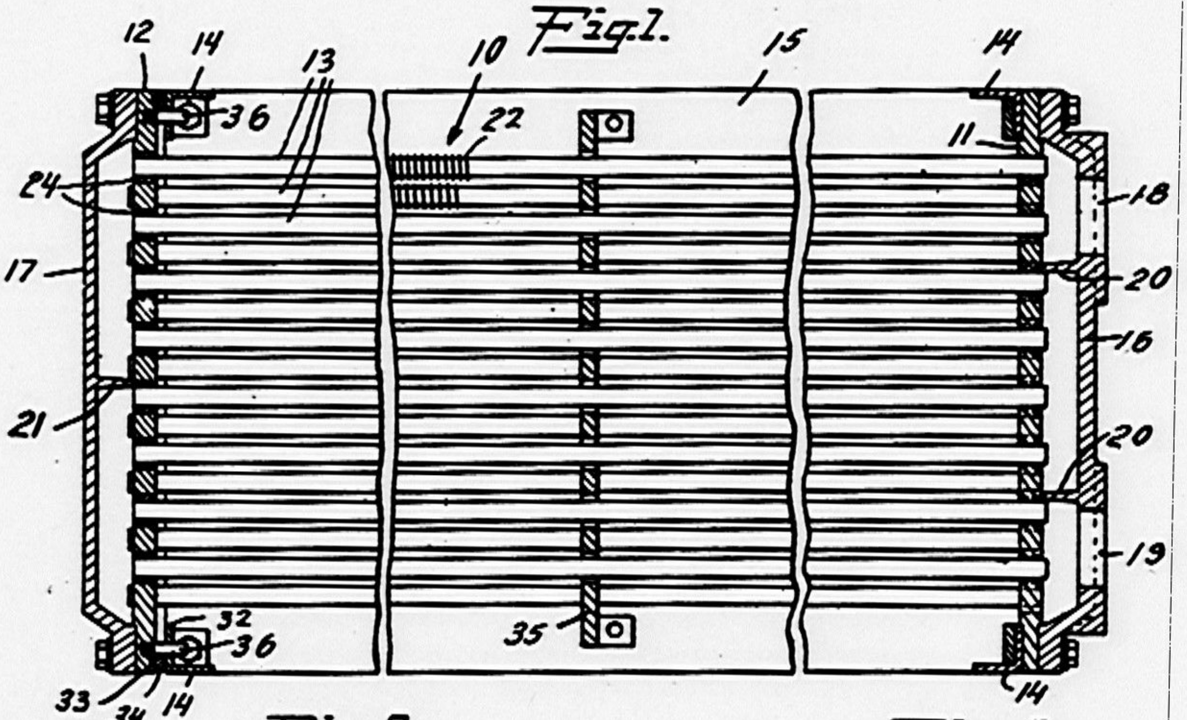


Fig. 2.

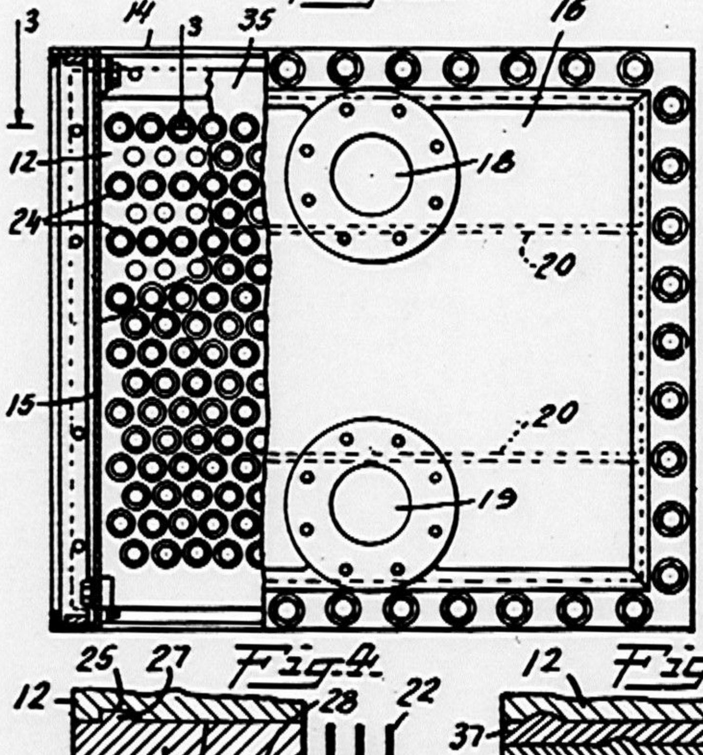


Fig. 3.

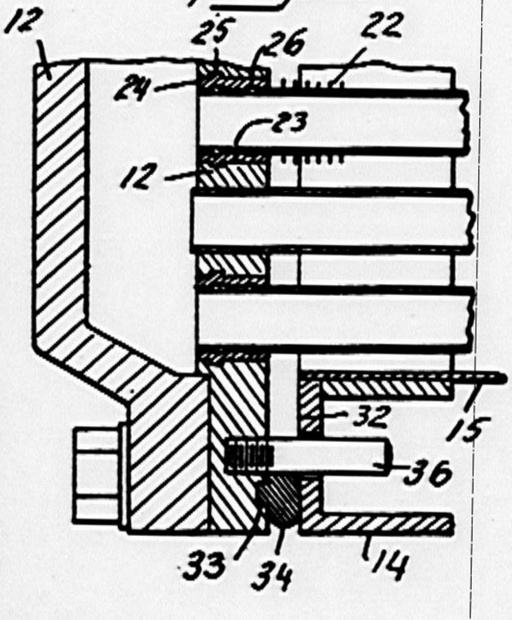


Fig. 4.

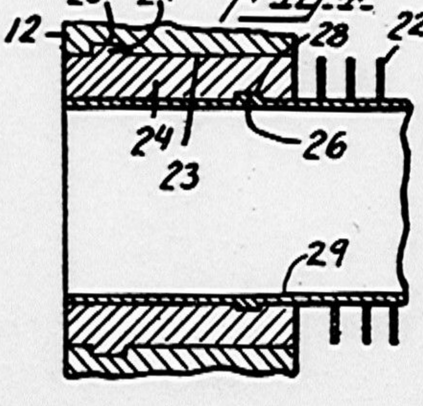
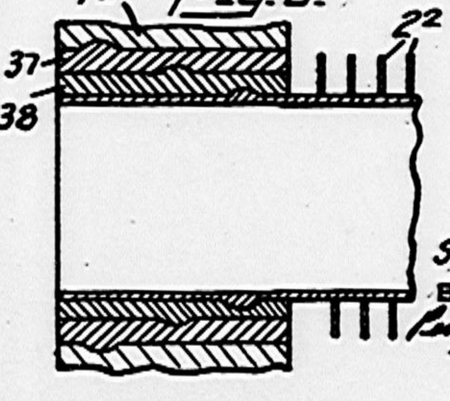


Fig. 5.



INVENTOR
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May 3, 1932. S. BROWN 1,856,618

HEAT EXCHANGER

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Fig. 6.

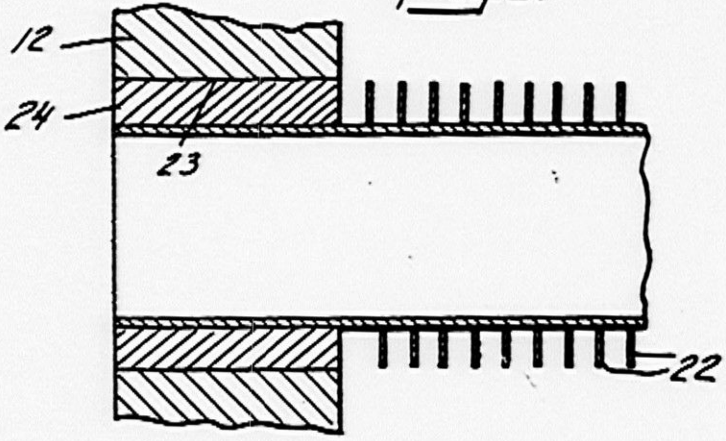


Fig. 7.

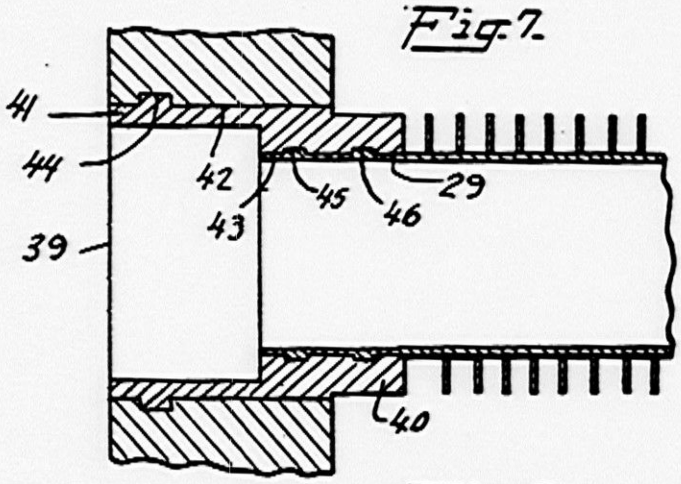


Fig. 8.

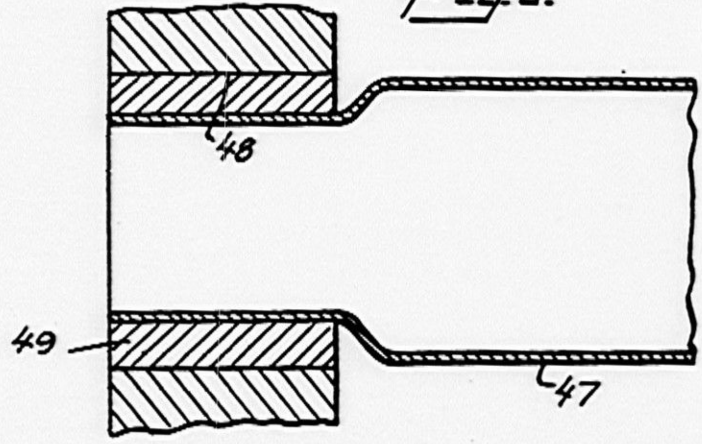
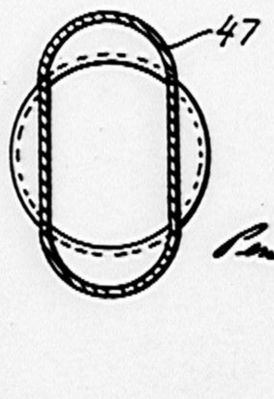


Fig. 9.



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Patented May 3, 1932 **1,856,618**

UNITED STATES PATENT OFFICE

STANLEY BROWN, OF GARDEN CITY, NEW YORK, ASSIGNOR TO THE GRISCOM-RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

HEAT EXCHANGER

Application filed May 23, 1930. Serial No. 455,035.

This invention relates chiefly to heat exchangers of the type in which a bundle of tubes is supported between tube sheets and surrounded by a suitable casing. The invention concerns more particularly heat exchangers of this type in which the tubes are provided with external fins or the like, for the purpose of increasing the heat transferring surface of the tubes.

Such heat exchangers are used largely in transferring heat from a liquid, usually passed through the inside of the tubes, to a gas which is circulated over the outsides of the tubes. Thus, for example, heat exchangers of this kind are employed in connection with the cooling of large electric generators. When used for this purpose the exchanger is connected in a duct system with the generator, and air or other gas, for example hydrogen, is circulated through this duct system, the gas being heated during its passage through the generator, thereby removing heat from the generator, and the gas being cooled in passing through the heat exchanger.

In heat exchangers of this kind, it is sometimes desirous to remove individual tubes from the tube bundle for inspection or repair, and with the ordinary heat exchanger construction this is very laborious, if not impossible, because of the presence of the external fins upon the tubes. Accordingly, an important object of the present invention is to provide a construction in which the individual tubes can be readily removed from, and replaced in the tube bundle without damage to the external fins which are ordinarily comparatively fragile and easily injured.

Another object of the invention is to accomplish the object just referred to, and still preserve adequate strength in the tube sheets.

A further object of the invention is to provide means for joining the tubes to the tube sheets in such a way as to effectively prevent leakage without greatly increasing the cost of making these joints over the cost of the ordinary plain expanded joint.

The invention will be understood from a consideration of the accompanying drawings, which, by way of example, illustrate the invention as applied to a generator air cooler.

In these drawings,

Fig. 1 is a central vertical section through the heat exchanger.

Fig. 2 is an end view looking from the right end of Fig. 1, but with parts broken away so as to show the tube sheet at the rear or left hand end as well as at the front or right hand end of the exchanger.

Fig. 3 is an enlarged fragmentary horizontal section taken on line 3—3 of Fig. 2.

Fig. 4 is a still further enlarged section of the improved joint between the end of a tube and tube sheet.

Fig. 5 is a view similar to Fig. 4 of a modified form of joint.

Fig. 6 is an enlarged longitudinal section through a single tube and a portion of a tube sheet showing a somewhat simpler form of the improved tube and tube sheet joint.

Fig. 7 is a similar view of another modified form of joint.

Fig. 8 is a similar view of the simplified form of joint shown in Fig. 6 shown in connection with a tube having an oval cross section at its central portion; and

Fig. 9 is a cross sectional view of the tube shown in Fig. 8.

Referring now to the accompanying drawings, the tube bundle 10 is supported by the tube sheets 11 and 12, respectively, the tube bundle consisting of a relatively large number of closely spaced fin tubes 13. The tube sheets 11 and 12 are supported upon the ends of the casing of the heat exchanger, which consists of the steel shapes or sections 14, and sheet metal plates 15 at both the near and far sides of the exchanger, as viewed in Fig. 1.

The air ducts connecting the exchanger with the generator are joined to the casing at the top and bottom, respectively, so that the air or gas passes vertically through the tube bundle.

A head 16 is bolted around the rectangular periphery of the tube sheet 11, and a similar head 17 is similarly bolted to the opposite tube sheet 12. The head 16 is provided with a flange inlet 18 and a flange outlet 19 for the water or other cooling fluid. The heads 16 and 17 are provided with horizontal divisions or partition walls 20 and 21, respectively, by which the cooling fluid is made to pass through the tube bundle four times in traveling from the inlet 18 to the outlet 19, or in other words, the heat exchanger illustrated is a so-called four-pass exchanger.

The tubes 13 are of uniform cross section throughout their length, and are provided throughout their central portions and extending for substantially the entire distance between the tube sheets 11 and 12, with metallic fins 22. These fins 22 are preferable arranged in equally spaced relation, and are secured upon the outside surfaces of the tubes in good heat exchanging relation with the metal of the tubes so that heat may pass readily by conduction between the fins and the walls of the tubes. These fins are preferably of helical form and applied to the tubes by grooving the same and winding a metal ribbon into the groove, and then upsetting the metal of the tube against the base of the helical fin. This method of applying the fins produces a joint between fin and tube of excellent heat conductivity. However, other methods of applying the fins may be employed. For example, helical fins may be secured to the surface of the tube by soldering or brazing, or the fins may be applied as individual annular discs secured to the tube in spaced relation by soldering, brazing, or in any other suitable manner.

Referring now particularly to Figs. 3, 4, 5 and 6, the improved joint construction which I employ is as follows: A hole 23 is punched in one of the tube sheets, say for example, tube sheet 12, of slightly larger diameter than the diameter of the fins 22, so that the tube with the fins thereon will slide readily through this aperture. A sleeve or thimble 24 surrounds the end of the tube and fills the annular space between the tube and the walls of hole 23, the sleeve being of substantially the same annular thickness as the width of the fins 22. Sleeve 24 is expanded in any suitable manner so that its exterior surface is forced into intimate contact with the contiguous surface of hole 23. The tube is also similarly expanded into intimate contact with the interior surface of sleeve 24.

For some uses of the heat exchanger, sufficiently tight joints are formed in the manner just described and which is illustrated in Fig. 6. However, in order to provide a joint that will withstand greater pressure and to enable the tubes 13 to withstand a greater longitudinal stress or thrust with respect to the tube sheet, an annular groove 25 (see Figs. 3, 4 and 5) is formed in the wall of hole 23 in the tube sheet, and a similar groove 26 is formed in the interior wall of sleeve 24. Then in expanding the sleeve 24 into the hole 23 by means of a suitable expanding tool, a rib 27 is formed on the surface of sleeve 24 which projects into and fills the annular groove or recess 25. Similarly in expanding the tube into the sleeve, the expanding tool forms a rib 28 on the outside of the tube which projects into and fills recess 26. These two sets of ribs and grooves are preferably displaced from one another as shown, so that they will not lie in a common plane.

In addition to preventing longitudinal displacement of the tubes with respect to the tube sheet, the rib and groove construction just described facilitates the making of tight joints between the tube and the sleeve and between the sleeve and the tube sheet. In other words, the ordinary use of the expanding tool in the hands of the ordinary workman will produce a much larger percentage of tight joints when the rib and groove construction is used than when the ribs and grooves are omitted and the surfaces are left smooth. The ribs and grooves preferably have approximately straight radial walls.

In expanding the sleeve into the tube sheet hole 23, a general displacement or flowing of the metal of the sleeve takes place, in causing the formation of the rib 27, which reduces slightly the thickness of the sleeve. Similarly, when the tube is expanded into the sleeve, a very slight thinning of the wall of the tube takes place, as indicated at 29 in Fig. 4.

The opposite end of each tube of the tube bundle 10 is secured in its tube sheet in the usual manner by expanding the tube into a tube hole of customary size which is only slightly larger than the diameter of the tube. The tube sheets 11 and 12 are each punched with alternate large and small tube receiving holes so that alternate tubes are secured in the tube sheet by means of the improved form of joint above described, and the intermediate tubes are expanded into holes of ordinary size in the usual manner. This, for example, is shown in Fig. 3 which is a section taken centrally through the first three tubes at the left hand end of the uppermost row of tubes shown in Fig. 2. It will be seen that two of these tubes are secured in tube sheet 12 by means of the improved form of joint, and the intermediate tube passes through a tube aperture of substantially the same size as the tube and into which it has been expanded.

The procedure in removing and inserting a faulty tube is as follows. The caps or heads 16 and 17 are first removed from the heat exchanger so as to expose the tube sheets 11 and 12. The faulty tube is located, and its sleeve 24 together with the end of the tube are drilled away following the same procedure as would be followed in removing a tube which had been expanded into a tube hole in the ordinary manner. The only difference is that there is more metal to be

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drilled away, and for this reason and also to aid in expanding the relatively thick sleeve 24, it is made of soft and easily workable metal.

The opposite end of the tube which is secured to its tube sheet by means of a plain expanded joint is then drilled out in the usual manner, and the tube is thus freed from both tube sheets. The tube is then slid through the large hole, that is the tube sheet hole which was first drilled out, this hole being just enough larger in diameter than the fins to permit the fins to slide through it. If any of the rib 27 has been left in the groove 25 after the drilling operation, this is now cut out and the apparatus is ready to have a new tube inserted.

The new finned tube is passed through the hole 23 until its inner end is received in the tube sheet having the small tube hole, and this end of the tube is expanded into this hole in the usual manner. Then a new sleeve 24 is inserted around the end of the tube which is in the large tube hole 23. This sleeve has previously been machined to a fairly close fit in hole 23, and it is driven inwardly until its outer end is flush with the outer surface of the tube sheet. The length of the sleeve being equal to the thickness of the tube sheet, its inner end will then be flush with the inner surface of the tube sheet. An appropriate expanding tool is then applied to the interior of the new tube, and the sleeve and tube are expanded simultaneously until the metal of the sleeve and tube is forced outwardly into the grooves 25 and 26, forming the interlocking ribs 27 and 28. If desired the sleeve may be placed upon the tube and the end of the tube expanded into the sleeve before the tube is placed in position within the heat exchanger. Then after the insertion of the tube, the assemblage of sleeve and tube is together expanded into the tube sheet. This completes the insertion of the tube and the caps 16 and 17 may then be replaced and the heat exchanger restored to surface.

In the modified form of tube joint shown in Fig. 5, a plurality of concentric sleeves are used in place of a single sleeve. In the particular form illustrated, two concentric sleeve 37 and 38 are employed, sleeve 37 being expanded into the hole in the tube sheet first, and the inner sleeve 38 then expanded into the sleeve 37. The tube is, of course, expanded into inner sleeve 38. In this figure, the bead-like form of rib and groove is shown in place of the square form with radial sides shown in the other figures. The square form is, however, preferred. This form of joint is intended more especially for use where the width of the fins is unsually large as compared with the diameter of the tube, and it will be understood that the expanding operations are rendered easier to carry out because of the thinner sleeves.

In the present heat exchanger, the construction shown in the lower part of Fig. 3 and at the left hand end of Fig. 1, is employed for the purpose of compensating for the longitudinal expansion and contraction of the tubes 13. In this construction the caps 17 are bolted to the tube sheet 12, but the tubes are not secured fast to the heat exchanger casing, but are mounted in such a way as to permit the cap and tube sheet to move closer to or further away from the end of the casing as the tubes contract or expand. The end of the casing has a relatively wide face 32 formed by a part of the steel angle 14 of the framework, and a groove 33 is formed near the periphery of the inner face of the tube sheet 12. A gasket 34 of resilient material such as rubber, is placed between the inner face of a tube sheet, and face 32 of the end of the casing, and is retained in position by the groove 33. This resilient gasket is placed under an initial compression so as to deform it from its original natural conformation. Thus, the cross section of the gasket shown in Fig. 3 and Fig. 1, before assembling is round, and it is compressed to approximately the shape shown in these figures when the apparatus is assembled. Any further contraction of the tubes compresses the gasket still more, and when the tubes are elongated by expansion so that the tube sheet moves further away from the face 32, the resiliency of the gasket is sufficient to fill this greater spacing and prevent leakage from the interior of the casing. In other words, the positioning of tube sheet 12 with respect to the end face 32 of the casing is such that a very considerable initial compression is imparted to gasket 34, and the resiliency of the gasket is sufficient to take care of the maximum amount of movement of the tube sheet either toward or away from the casing caused by contraction or expansion of the tubes 13.

In order to support the tube sheet 12 in cap 17 so as to allow for movement of these parts with respect to the end of the casing, and also to prevent lateral movement of the tube sheet with respect to the face 32 which would tend to displace gasket 34, a plurality of guide studs 36 are employed, two of which are shown in Fig. 1. These guide studs are tapped into tube sheet 12 from its inner face, and project through apertures in the face 32 of the casing. The studs 36 are received in these apertures with a sliding fit and thereby support the tube sheet and its cap so that they can move easily during expansion and contraction and still be maintained in their proper position. The studs 36 are arranged inside of gasket 34 so as to avoid leakage.

The tubes of the tube bundle are supported intermediate their ends by means of a perforated plate 35, which is fixed in any convenient manner to the heat exchanger casing. The perforations in plate 35 as indicated in

Fig. 1 are slightly larger than the fins so that the finned tubes may be easily passed through them. As the support given to each of the tubes by this perforated plate is imparted directly to the edges of the fins, the plate is made relatively thick so that it will span a plurality of fins.

We will now refer to the modified form of joint shown in Fig. 7. In this modification the sleeve 39 is the annular filler sleeve shown in the previous figures of the drawings recessed at its outer end and provided with a longitudinal extension 40 at its inner end. The recess at the outer end of the sleeve reduces the thickness of the annular portion 41 of the sleeve within the tube sheet aperture 42 so that it is easier to expand the sleeve into the tube sheet.

The extension 40 on the inner side of the sleeve is provided with a tube receiving aperture 43 of a diameter corresponding to that of the tube so that the tube may be expanded into this aperture in the same manner as the tube would be expanded directly into an ordinary tube sheet aperture.

While for some conditions of service, the joint between the tube and aperture 43, and the joint between the sleeve 39 and aperture 42 may be plain joints, it is desirable under most conditions to employ the rib and groove form of joint previously described. Thus a single relatively large rib and grooves 44 are shown in Fig. 7 between the annular recessed portion 41 and aperture 42 of the tube sheet. Between the tube and the aperture 43 of the sleeve, it is desirable to employ a multiple rib and groove structure in which each individual rib and groove is relatively small. In this way the forces applied during the formation of the rib by the expanding tool are reduced so as to prevent deformation of the extension 40 which, because it projects beyond the surface of the tube sheet, is unsupported thereby.

In Fig. 7 two such rib and groove joints 45 and 46 are shown. The rib and groove 45 are located within the aperture 42 of the tube sheet so that if there is any swelling or enlargement of the sleeve 39 during their formation, this merely tends to improve the tightness of the joint between the sleeve and aperture 42. The rib and groove 46, however, are located entirely within the extension 40. The diameter of the longitudinal extension 40 is preferably made the same as the diameter of the fins 22 which is substantially equal to the diameter of the tube aperture 42 but just enough smaller than this aperture to enable the fins to slide readily therethrough.

In Figs. 8 and 9 the central portion of the tube 47 is of flattened or elliptical cross section as shown in Fig. 9 and may be smooth or it may be provided with fins at least upon its flattened sides. The width of the flattened tube is such as to just slide through the tube aperture 48 in the tube sheet, and the end of the tube, which is circular, is expanded into a plain sleeve 49 which is similar to the sleeve illustrated in Fig. 6. Sleeve 49 is expanded into the aperture in the tube sheet. Instead of using a plain sleeve, the rib and groove joints previously described may be used, or the form of sleeve described in connection with Fig. 7 may also be employed.

It will be understood that the central portion of tube 47 and the central portions of the tubes shown in the remaining figures of the drawings are both enlarged, in the case of the tube of Fig. 8 by the flattening of the tube, and in the case of the tubes of the other figures, by the provision of fins thereon.

I claim:

1. In a heat exchanger, a tube having outwardly projecting fins on its central portion for increasing the heat transmitting surface of the tube, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than the outside dimension of the fins so that the said finned tube can be removed from the exchanger through said aperture, a sleeve within said aperture surrounding the end of the tube, a coacting rib and groove on the sleeve and tube sheet respectively, and a similar coacting rib and groove on the tube and sleeve displaced out of the plane of said first-mentioned rib and groove, the surfaces of the sleeve opposite the rib and groove therein being smooth.

2. In a heat exchanger, a tube of uniform cross-section provided with outwardly projecting fins for increasing the heat transmitting surface of the tube, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than the outside diameter of the fins so that said finned tube can be removed from the exchanger through said aperture, and means for securing the end of the tube in said tube aperture comprising a sleeve within said aperture surrounding the end of the tube, a coacting rib and groove on the sleeve and tube sheet respectively, and a similar coacting rib and groove on the tube and sleeve displaced out of the plane of said first-mentioned rib and groove, the surfaces of the sleeve opposite the rib and groove therein being smooth.

3. In a heat exchanger, a tube having at its central portion means effecting an enlargement of the outside dimension of said central portion, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than said outside dimension, and means for securing the end of said tube in said tube sheet comprising a sleeve having a recessed portion at its outer end and an offset portion at its inner end, said recessed portion being expanded into said tube sheet, and the end of said tube being expanded into said offset portion.

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4. In a heat exchanger, a tube having at its central portion means effecting an enlargement of the outside dimension of said central portion, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than said outside dimension, and means for securing the end of said tube in said tube sheet comprising a sleeve having an outer recessed portion and an inner offset portion, the recess in said outer portion being larger in diameter than the end of said tube and being expanded into said tube aperture, said offset portion extending inwardly beyond the inner surface of the tube sheet and having a relatively thick wall capable of withstanding the expansion stresses of the end of the tube therein without substantial distortion, the end of said tube being expanded into said offset portion of said sleeve.

5. In a heat exchanger, a tube of uniform cross-section provided with outwardly projecting fins for increasing the heat transmitting surface of the tube, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than the outside diameter of said fins so that said finned tube can be removed from the exchanger through said aperture, and means for securing the end of the tube in said aperture comprising a sleeve having a relatively thick annular wall surrounding the end of the tube and into which the end of the tube is expanded, and a portion having a relatively thin annular wall disposed outwardly from said thick walled portion and expanded into the tube aperture in the tube sheet.

6. In a heat exchanger, a tube bundle containing tubes of uniform cross-section provided with outwardly projecting fins for increasing the heat transmitting surface of the tubes, a pair of tube sheets for supporting the said tubes at their ends, said tube sheets each having alternate large and small tube apertures therein, the large apertures in one sheet being in alignment with the small apertures in the opposite tube sheet and the large apertures being slightly larger than the fins so as to permit the removal of the said finned tubes therethrough, a sleeve expanded into each of said large apertures, means for connecting one end of a tube with each of said sleeves, and the opposite end of the tube being expanded into the small aperture in the opposite tube sheet.

7. In a heat exchanger, a tube having at its central portion means effecting an enlargement of the outside dimension of said central portion, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than said outside dimension, and means for securing the end of said tube in said tube sheet comprising a sleeve of greater length than the thickness of said tube sheet, said sleeve having a recess in its outer portion of less length than the thickness of said tube sheet and of larger diameter than said tube, a coacting rib and groove respectively on the outer surface of the sleeve and the wall of the tube aperture in the tube sheet, and a coacting rib and groove respectively on the outer surface of said tube and the inner wall of said sleeve and located longitudinally between the outer and inner surfaces of said tube sheet.

8. In a heat exchanger, a tube having at its central portion means effecting an enlargement of the outside dimension of said central portion, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than said outside dimension, and means for securing the end of said tube in said tube sheet comprising a sleeve the inner portion of which envelopes said tube and the outer portion of which extends beyond the end of the tube, said outer portion being secured to said tube sheet and the end of said tube being secured to said inner portion.

9. In a heat exchanger, a tube provided with means for increasing the heat transferring surface of the tube, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than the outside diameter of said tube so that the same can be removed from the exchanger through said aperture, and means for securing the end of the tube in said aperture comprising a sleeve having a relatively thick annular wall surrounding the end of the tube and into which the end of the tube is expanded, and a portion having a relatively thin annular wall disposed outwardly from said thick walled portion and expanded into the tube aperture in the tube sheet.

10. In a heat exchanger, a tube bundle containing tubes provided with means for increasing the heat transferring surface of the tubes, a pair of tube sheets for supporting the said tubes at their ends, said tube sheets each having alternate large and small tube apertures therein, the large apertures in one sheet being in alignment with the small apertures in the opposite tube sheet and the large apertures being slightly larger than the tubes so as to permit the removal of the said tubes therethrough, a sleeve expanded into each of said large apertures, means for connecting one end of a tube with each of said sleeves, and the opposite end of the tube being secured in the small aperture in the opposite tube sheet.

11. In a heat exchanger, a tube having at its central portion means effecting an enlargement of the outside dimension of said central portion, a tube sheet for supporting one end of said tube and having a tube aperture slightly larger than said outside dimension, and means for securing the end of said tube in said tube sheet comprising a sleeve of greater length than the thickness of said

74

tube sheet, said sleeve having a recess in its outer portion of less length than the thickness of said tube sheet and of larger diameter than said tube, a coacting rib and groove respectively on the outer surface of the sleeve and the wall of the tube aperture in the tube sheet, and a coacting rib and groove respectively on the outer surface of said tube and the inner wall of said sleeve.

12. In a heat exchanger, a tube having means effecting an enlargement of the outside dimension of the central portion of the tube, a tube sheet for supporting one end of the tube and having a tube aperture slightly larger than said outside dimension, and means for securing the end of said tube in said tube sheet comprising an outer sleeve expanded into said tube aperture and an inner sleeve expanded into said outer sleeve, the said tube being secured to said inner sleeve.

In testimony whereof I affix my signature.

STANLEY BROWN.

Oct. 22, 1935. E. N. SIEDER 2,018,037

HEAT EXCHANGER

Filed Sept. 29, 1933 3 Sheets-Sheet 1

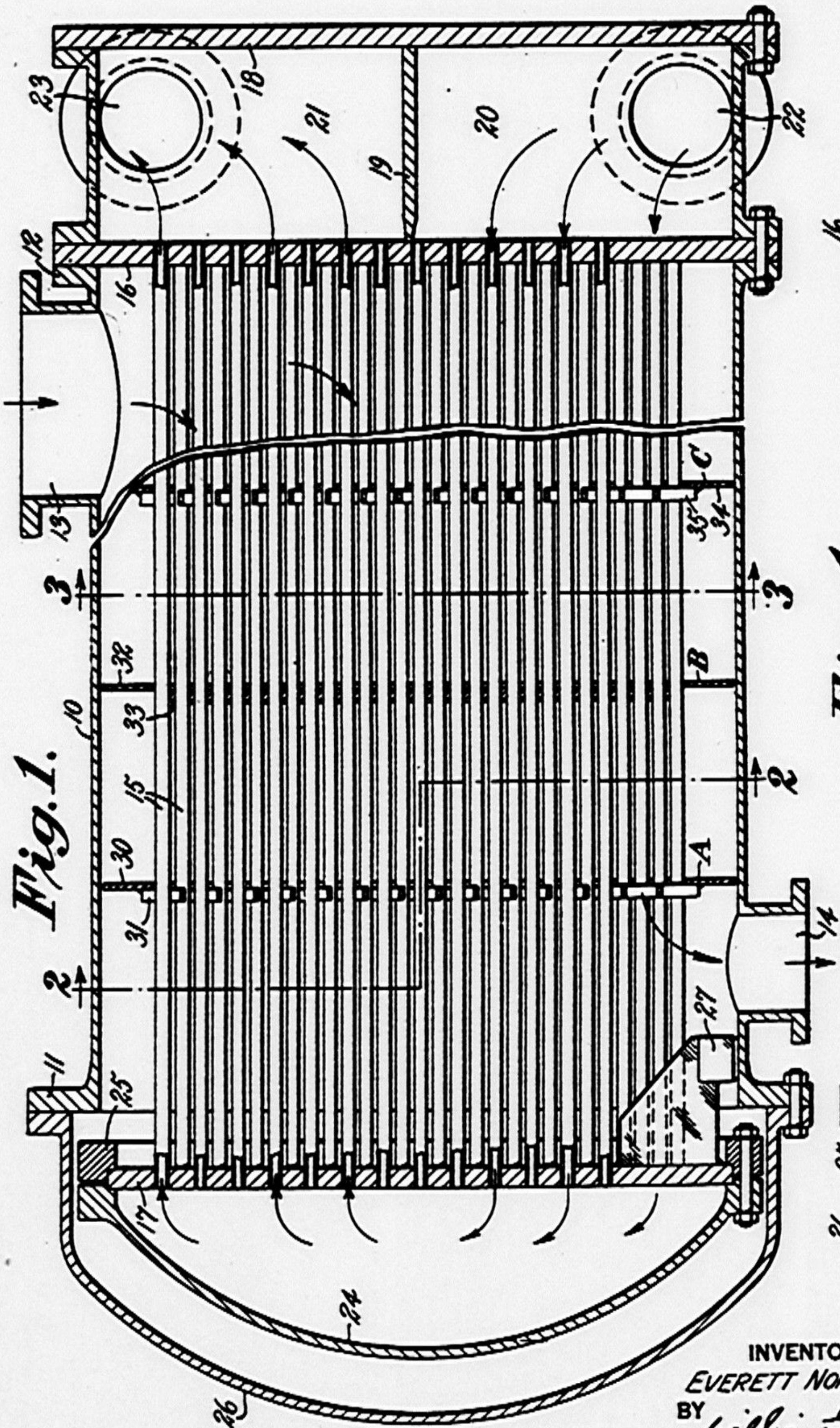

Fig. 1.

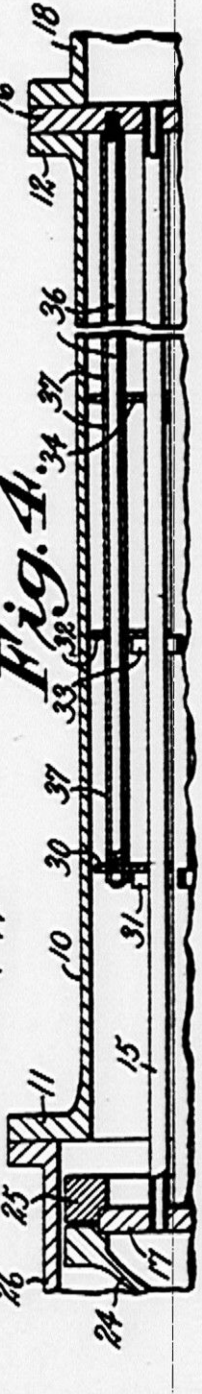

Fig. 4.

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HEAT EXCHANGER

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Fig. 2.

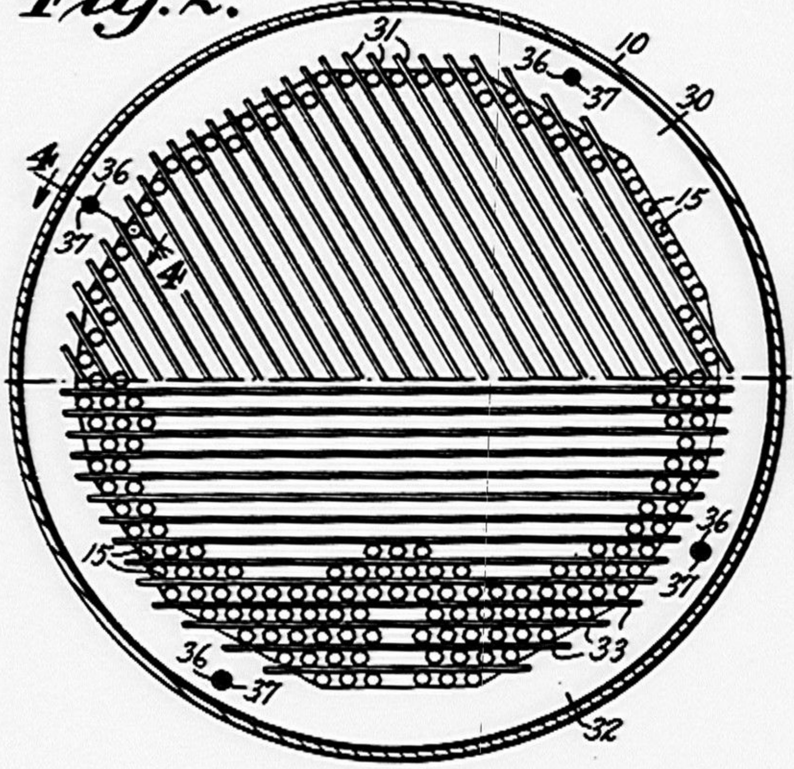
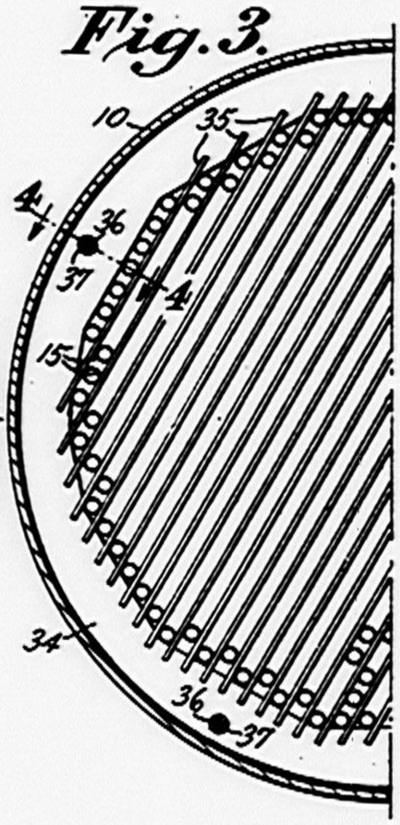


Fig. 3.



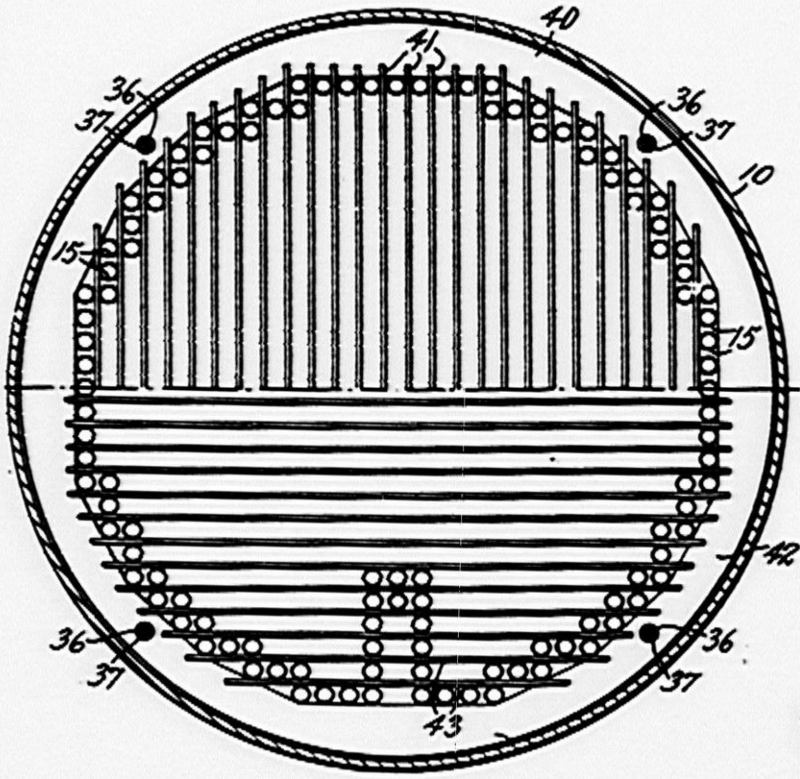


Fig. 6.

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HEAT EXCHANGER

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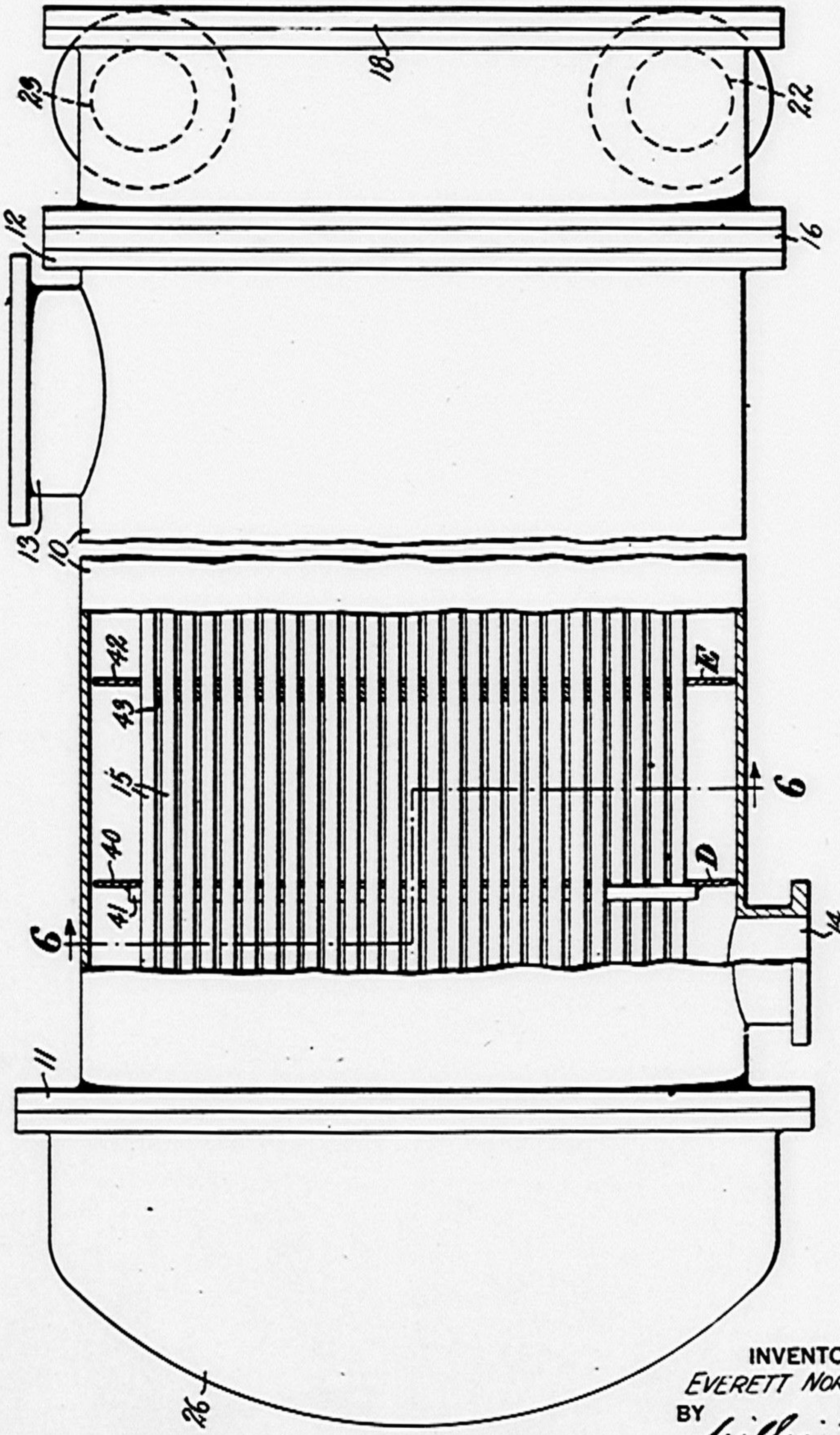

Fig. 5.

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Patented Oct. 22, 1935 2,018,037

UNITED STATES PATENT OFFICE

2,018,037

HEAT EXCHANGER

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Application September 29, 1933, Serial No. 691,446

16 Claims. (Cl. 257—239)

This invention relates to heat exchangers and more particularly pertains to heat exchangers of the tube and shell type and to supporting means for the tubes intermediate their ends.

The invention provides novel supporting means for the intermediate portions of the tubes so arranged that maximum support for the tubes with a relatively small restriction of flow area through the tube bundle is provided.

This is accomplished in general, by means extending through or disposed in the lanes between rows of tubes, such as bars or rods in contact with the tubes, and suitably supported at their ends, preferably beyond the tube bundle. The number of such supporting means employed and their location and direction of extent through the tube bundle will depend upon the lengths of the tubes and the character of their spacing.

The nature of the invention will be understood from the following description considered in connection with the accompanying drawings forming a part thereof and illustrating preferred forms of the invention, and in which:

Fig. 1 is a longitudinal sectional view of a heat exchanger embodying one form of the present invention;

Fig. 2 is a transverse sectional view taken substantially on line 2—2 of Fig. 1;

Fig. 3 is a partial transverse sectional view taken substantially on line 3—3 of Fig. 1;

Fig. 4 is a partial longitudinal sectional view taken substantially on lines 4—4 of Figs. 2 and 3;

Fig. 5 is an elevational view partly in section of a heat exchanger embodying another form of the invention; and

Fig. 6 is a transverse sectional view taken substantially on line 6—6 of Fig. 5.

Like characters of reference refer to like parts throughout the several views.

Referring to the drawings, reference character 10 designates the cylindrical shell of a heat exchanger embodying the present invention and having annular flanges 11 and 12 at its opposite ends. Shell 10 is provided with an inlet 13 in its upper portion and an outlet 14 in its lower portion. A plurality of tubes 15 disposed within and extending longitudinally of the shell 10 as shown, are expanded into or otherwise secured at one end to a stationary tube sheet 16 and at the other end to a floating tube sheet 17 of such dimensions that it may be passed through the shell when the tube bundle is withdrawn. Tube sheet 16 is secured by suitable means to the flange 12 of the shell 10 and a header 18 is secured to the tube sheet 16, as shown. The header 18 is divided by a longitudinally extending partition 19 into an inlet compartment 20 and an outlet compartment 21. Fluid is introduced into the compartment 20 through an inlet 22 and after passing through the tubes 15, is withdrawn or discharged from the exchanger and compartment 21 through an outlet 23. A cover 24 is secured to the floating tube sheet 17 by suitable means such as the split ring 25 which engages the inner periphery of the tube sheet 17 and is bolted to the flange of the cover 24 which abuts the outer periphery of tube sheet 17. A shell cover 26 is secured to the annular flange 11 of the shell 10. Suitable means, indicated generally 27, may be utilized to support the floating tube sheet 17 on the shell 10.

In the forms of the invention shown in the drawings, the supporting means for the intermediate portions of the tubes comprises a plurality of groups of bars of any suitable material disposed in the lanes between tube rows and which are maintained in proper position by suitable means such as herein disclosed. The number of bar groups utilized and their particular disposition will depend upon the character of the spacing of the tubes and upon the length of the tubes. In the form of the invention disclosed in Figs. 1 to 4 inclusive, the tubes are spaced on a triangular pitch, that is to say, the tubes are spaced so that the lines of centers of the several rows of tubes form triangles. In this form of the invention three separate spaced groups of bars are utilized to provide a supporting unit for the intermediate portions of the tubes. The number of these units which are employed will depend of course upon the length of the tubes utilized in the heat exchanger. As shown in Figs. 1 to 4 inclusive, the three groups of supporting bars which form a supporting unit are designated respectively A, B, and C. The supporting group A consists of an annular plate 30 which is disposed transversely of the tube bundle in the annular space between the shell 10 and the tube bundle 15 with its diameter somewhat smaller than the inside diameter of the shell, and having its inner peripheral portion formed so as to contact the outermost tubes of the bundle, as clearly shown in Figs. 2 and 3 and the supporting bars designated 31 having rectangular cross-sectional configurations, which are disposed between the horizontally inclined tube rows extending in a direction from upper left to lower right as seen in Fig. 2. These bars, as shown, are positioned with their sides or longer cross-sectional dimensions in contact with the tubes and are secured at their ends to the annular plate 30 by suitable means, such as by welding or the like. Supporting group B consists of a transversely disposed annular plate 32 similar to the plate 30, and a plurality of spaced bars 33 similar to the bars 31 disposed between the horizontal rows of tubes 15, as shown in Figs. 1 and 2. The supporting group C consists of a transversely disposed annular plate 34 also similar to plate 30, and a plurality of spaced bars 35 similar to bars 31 which are disposed between the horizontally inclined rows of tubes extending in a direction from upper right to lower left, as seen in Fig. 3.

The tube supporting groups A, B, and C are maintained in spaced relationship by suitable means such as the tie bolts 36, shown. These tie bolts are threaded into the stationary tube sheet 16 and carry cylindrical spacing members 37, the ends of which engage the annular plates 30, 32, and 34 and tube sheet 16 to maintain them in the desired spaced relationship. The supporting plates 30, 32 and 34 in addition to supporting the bars 31, 33 and 35 function as baffle plates to prevent short circuiting of the vapors or fluids which pass through the shell 10, through the annular space between the shell and the tube bundle.

With the tube supporting arrangement so far described, it will be perceived that each of the tubes of the tube bundle, with the exception of a few tubes at the periphery of the bundle, are engaged by the supporting bars at spaced points or lines of contact which are disposed about the periphery of the tubes. In this manner, the intermediate portions of the tubes are adequately supported against buckling or distortion and yet are free to expand and contract along their lengths and this support is provided with a relatively small restriction of flow area through the tube bundle.

Where the tubes are spaced on a square pitch, that is to say where the lines of centers of the tubes intersect at approximately right angles to each other, the supporting units for the intermediate portions of the tubes consist of two groups of supporting bars designated generally D and E, as shown in Figs. 5 and 6. The supporting group D consists of an annular supporting plate 40 similar to plate 30 and a plurality of bars 41 similar to the bars 31, but disposed in a substantially vertical direction between the vertical rows of tubes of t tube bundle, as seen in Fig. 6. The supporting group D consists of an annular plate 42 similar to the plate 30 and a plurality of bars 43, similar to the bars 31 but which are horizontally disposed and extend between the horizontal rows of tubes 15, as seen in Fig. 6. With this arrangement it will be seen that each of the tubes with the exception of a few at the periphery of the tube bundle is supported at spaced points which are disposed at approximately 90° to each other about the circumference of the tubes. As many of the supporting units consisting of the two groups of supporting bars as shown and described may be utilized, to provide the desired support for the intermediate portions of the tubes. In the embodiments of the invention disclosed, the plates which support the tube supporting bars or rods are not connected to the shell 10, so that they may readily be withdrawn from the shell with the tube bundle.

Although supporting bars having rectangular transverse cross-sectional configurations are disclosed, it will be apparent that bars or rods having cross-sectional configurations such as circular, triangular or square may be utilized, if desired, and it will be understood that the words "bar" and "bars" as used in this specification and in the claims hereto appended are intended to include rods or bars of cross-sectional configurations other than the rectangular configuration disclosed. Ordinarily, the bars should possess cross-sectional dimensions such that the bars will contact and support the tubes on both sides of the lanes in which the bars are disposed to provide the maximum support for the tubes.

To those skilled in the art to which this invention relates, it will be apparent that the supporting means herein disclosed possesses decided advantages over the so-called half-circle supporting plates or ring type baffles which have heretofore been utilized. These prior types of baffles invariably produce a dead flow area at one side of these baffles, which area increases with the amount of support which the baffles provide. To overcome this dead area it has been customary in the past to divide the tube support so that each baffle or supporting plate would support about twenty-five per cent of the tubes of the bundle but with this arrangement it will readily be seen that it would require four or more successive baffles or supporting plates of this character to complete one tube supporting unit.

By utilizing the tube supporting means herein disclosed it has been possible to design vertical condensers for high vacuum distillation units where a minimum pressure drop is required. Such condensers may be made a part of the fractionating tower for small vacuum units and may be advantageously utilized in lieu of the more costly design of external vapor condensers having two or more large vapor lines connecting it with the vacuum tower.

Although the invention has been shown and described as embodied in heat exchangers which are normally operated in a horizontal position, it will be evident that the principle of the invention may be employed in heat exchangers adapted for use in a vertical position.

It will be understood that inasmuch as changes in the forms of the invention herein disclosed may be made without departing from the principle of the invention, no intention is entertained to limit the extent of the invention except by the scope of the claims appended hereto.

What is claimed is:

1. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, and means comprising a plurality of groups of bars for supporting the tubes intermediate their ends, the bars in each group extending transversely of the tube bundle with the bars in one group extending in a direction different from that of the bars of another group.

2. Heat exchange apparatus comprising a shell, tubes within the shell forming a tube bundle, said bundle being spaced from the shell, a plate disposed within the shell in the space between the tube bundle and the shell and intermediate the ends of the tubes and unconnected with the shell, and a plurality of bars supported on said plate and disposed in the lanes between tube rows for supporting the tubes.

3. Heat exchange apparatus comprising a shell, tubes within the shell forming a tube bundle, said bundle being spaced from the shell, a plurality of spaced plates disposed in the shell in the space between the tube bundle and the shell and intermediate the ends of the tubes, and a plurality of bars supported on each plate and disposed in the lanes between tube rows for sup-

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porting the tubes, the bars secured to one plate extending in a direction different from that in which the bars secured to another plate extend.

4. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, said tubes being spaced so that the lines of their centers are at right angles to each other, and means for supporting the tubes intermediate their ends comprising a plurality of groups of bars extending transversely of the tube bundle and in contact with the tubes, the bars of one group extending in a direction at right angles to those of another group.

5. Heat exchange apparatus comprising a shell, spaced tube sheets, tubes within the shell connected to the tube sheets, one of said tube sheets being arranged to be secured to the shell, the other tube sheet being movable with respect to the shell upon expansion and contraction of the tubes and having overall dimensions such that it may be moved through the shell to provide for the removal of the tube sheets and tubes as a unit from the shell, and means removable from the shell with the tubes for supporting the tubes intermediate their ends, said means providing spaced contacts about the peripheries of the tubes intermediate their ends, the number of said contacts being sufficient to prevent transverse movement of the intermediate portions of the tubes in all directions.

6. Heat exchange apparatus comprising a shell, spaced tube sheets, tubes within the shell connected to the tube sheets, one of said tube sheets being arranged to be secured to the shell, the other tube sheet being movable with respect to the shell upon expansion and contraction of the tubes and having overall dimensions such that it may be moved through the shell to provide for the removal of the tube sheets and tubes as a unit from the shell, and means comprising a plurality of bars for supporting the tubes intermediate their ends, said bars being removable from the shell with the tubes.

7. Heat exchange apparatus comprising a shell, spaced tube sheets, tubes within the shell connected to the tube sheets, one of said tube sheets being arranged to be secured to the shell, the other tube sheet being movable with respect to the shell upon expansion and contraction of the tubes and having overall dimensions such that it may be moved through the shell to provide for the removal of the tube sheets and tubes as a unit from the shell, means comprising a plurality of bars for supporting the tubes intermediate their ends, and means independent of the shell for supporting said bars, said bars and their supporting means being removable from the shell with the tubes.

8. Heat exchange apparatus comprising a shell, tubes within the shell forming a tube bundle, means for supporting the tubes at their ends, means comprising a plurality of groups of bars for supporting the tubes intermediate their ends and preventing transverse movement of the intermediate portions of the tubes, and means for maintaining said groups of bars in spaced relationship.

9. Heat exchange apparatus comprising a shell, tubes within the shell forming a tube bundle, said bundle being spaced from the shell, a plurality of spaced plates disposed in the shell in the space between the tube bundle and the shell and intermediate the ends of the tubes, a plurality of bars supported on each plate and disposed in the lanes between tube rows for supporting the tubes, the bars secured to one plate extending in a direction different from that in which the bars secured to another plate extend, and means for maintaining said groups of bars in spaced relationship.

10. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, said tubes being spaced so that the lines of their centers are at right angles to each other, means for supporting the tubes intermediate their ends comprising a plurality of groups of bars extending transversely of the tube bundle and in contact with the tubes, the bars of one group extending in a direction at right angles to those of another group, and means for maintaining said groups of bars in spaced relationship.

11. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends and means providing spaced contacts about the peripheries of the tubes intermediate their ends, the number of said contacts being sufficient to prevent transverse movement of the intermediate portions of the tubes in all directions.

12. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, and rod-like means providing spaced contacts about the peripheries of the tubes intermediate their ends, the number of said contacts being sufficient to prevent transverse movement of the intermediate portions of the tubes in all directions.

13. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, and means comprising a plurality of bars providing spaced contacts about the peripheries of the tubes intermediate their ends, the number of said contacts being sufficient to prevent transverse movement of the intermediate portions of the tubes in all directions.

14. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, and means comprising a plurality of groups of bars providing spaced contacts about the peripheries of the tubes intermediate their ends, the number of said contacts being sufficient to prevent transverse movement of the intermediate portions of the tubes in all directions.

15. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, and means causing a relatively small restriction of the flow area between the tubes in the shell for supporting the tubes intermediate their ends and preventing transverse movement of the tubes in all directions.

16. Heat exchange apparatus comprising a shell, tubes within the shell, means for supporting the tubes at their ends, and means causing a relatively small restriction of the flow area between the tubes in the shell for supporting the tubes intermediate their ends and preventing transverse movement of the tubes in more than one direction and in the direction opposite thereto.

EVERETT NORMAN SIEDER.

BRIEF FOR APPELLEE

In the United States Court of Appeals for the District of Columbia

APPEAL NO. 8585

THE GRISCOM RUSSELL COMPANY, APPELLANT
v.
CONWAY P. COE, COMMISSIONER OF PATENTS, APPELLEE

APPEAL FROM THE JUDGMENT OF THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA

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UNITED STATES
COURT OF APPEALS FOR THE
DISTRICT OF COLUMBIA

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Joseph W. Stewart

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INDEX

Page
Introduction 1
Statement 2
The Appealed Claims 4
Summary of Argument 4
Argument 5
Conclusion 9
Authorities cited:
Cuno Engineering Corp. v. *The Automatic Devices Corp.*, 314 U. S. 84, 1942 C. D. 723 7
Morrison v. *Coe*, 74 App. D. C. 335, 122 F. (2d) 793, 1941 C. D. 75 8
Sieberling Rubber Co., v. *I. T. S. Co.*, 134 F. (2d) 871 9
Welter, In re, 28 C. C. P. A. 1160, 120 F. (2d) 353, 1941 C. D. 544 8

563923—43

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BRIEF FOR THE COMMISSIONER OF PATENTS

INTRODUCTION

This is an appeal from the judgment of the District Court of the United States for the District of Columbia (14)[1] dismissing the complaint (23) in Civil Action No. 14,229 brought under the provisions of Section 4915 R. S. (U. S. C., title 35, sec. 63), in which it was sought to have the Court adjudicate that the plaintiff is entitled to have issued to it a patent for Steam Generators on the application of its assignor, Kenneth B. Ris, Serial No. 300,907, filed October 24, 1939, containing claims 1 to 8 of said application.

STATEMENT

The application of Ris relates to improvements in bent tube self-scaling evaporators and such improvements are directed particularly to structural changes in such evaporators for use in oil refineries and the like. The structure disclosed is of the same type as that disclosed in the Price and Ris patent No. 1,842,945 (61) which was issued to plaintiff.

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[1] The numbers in parentheses refer to pages of appellant's appendix.

The device of that patent, like that of the present application, discloses a waste heat boiler generating steam from water in a shell by passing hot oil products through it in bent tubes.

The apparatus of the application comprises a heat exchanger of the shell and tube type, the tubes, which are bowed, being secured rigidly to two sheets bolted to the ends of the shell. As shown in the drawing, the left-hand tube sheet is smaller than the internal diameter of the shell and the right-hand tube sheet is bolted to an outside flange on the shell. The tubes are bowed so as to absorb the expansion between the tubes and the shell. Return bends are clamped on the outer sides of the tube sheets to provide fluid connections between the ends of different tubes. A longitudinal baffle sheet is placed over the tubes to prevent entrainment of water in the steam. This baffle sheet is supported on longitudinal members rigidly fastened to one of the tube sheets and held in nearly fixed relation to the other tube sheet, so as to permit expansion relative to the shell. The tubes are provided with supports intermediate their ends, which may be moved along tracks on the bottom of the shell.

The patent to Wilson No. 1,737,347 (55) discloses a heat exchanger comprising a block of metal having fluid passages therein and connections between different passages on the outside of the block.

The patent to Wright No. 1,435,364 (44) discloses tracks for facilitating the moving of a tube bundle into or out of a shell.

The patent to Sieder No. 2,018,037 (75) shows tube supports held in fixedly spaced relation by a combination of sleeves and rods.

The patent to Brown No. 1,856,618 (67) shows means for connecting the tube sheets of a tube assembly, rigidly at one end and with slight play at the other.

The patent to Jones No. 1,617,119 (47) shows a baffle placed over the tubes of a tube and shell assembly when used as an evaporator to prevent the en entrainment of liquid.

The examiner in his statement in answer to the appeal (36) said that the applicant had made changes in the Price et al. apparatus so as to gain individual advantages taught by the cited patents and which individually involved no invention.

The Board of Appeals affirmed the action of the Examiner and in its decision (40) said:

> Without discussing the claims in detail, we agree with the examiner that they involve nothing more than a mere bringing together, in a single structure, of various features which are all old in the art. It has repeatedly been said that the mere aggregation of old features, even though the assembly may produce a superior device, does not amount to invention. See, in this connection, the Supreme Court decision of *Hailes* v. *Van Wormer,* 20 Wall. 353; *Stove Co.* v. *Kelsey,* 158 F. (622); *Ex parte Fine,* 364 O. G. 511, 1927 C. D. 84 and *In re Small,* 271 O. G. 363.

THE APPEALED CLAIMS

The appealed claims will be found on pages 1 to 6 of the appendix and of them, claim 1 is illustrative.

> A steam generator comprising a shell and a removable assembled tube bundle unit, said tube bundle including a tube sheet adapted to pass into said shell and seal the other end thereof, a second tube sheet adapted to seal the other end of said shell, a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets, spacing means maintaining said tube sheets in nearly fixed spaced relation to each other independently of said shell and said tubes, said tube sheets constituting the exposed end walls of said shell, and removable fluid passages supported on said tube sheets exterior to said shell connecting said tubes in a predetermined arrangement of passes for the flow of heating fluid therethrough.

SUMMARY OF ARGUMENT

1. It is not invention to follow the teachings of the prior art.

2. Novelty and utility of a device are alone not sufficient to justify the grant of a patent therefor. It must appear that invention was involved.

3. The changes made by applicant in the apparatus of the Price et al. patent neither individually nor collectively show invention.

4. The question of invention must be determined in view of the prior art, whether that art is shown in one patent or in several patents.

ARGUMENT

The argument of appellant's brief is based largely on certain limitations of the claims, as establishing patentability over the art cited and further on the fact that several references are cited as showing details of construction specified in the claims.

The first part of the argument is based on the following limitations of claim 1 (a) "said tube sheets constituting the exposed end walls of the shell", (b) "removable fluid passage supported on said tube sheets exterior to the shell connecting said tubes arrangement of passes", and (c) "spacing means maintaining said tube sheets in nearly spaced relation to each other independently of said shell and said tubes".

The limitations (a) and (b) relate to the same feature of construction.

On cross examination the applicant, Ris, testified that it was not new to form a steam generator having a shell and a removable assembled tube bundle unit, said tube bundle unit including a tube sheet adapted to pass into said shell and seal one end thereof and a second tube sheet adapted to seal the other end of said shell, nor was it new to have a plurality of bowed tubes extending inside said shell between and affixed at either end into said tube sheets.

As stated by the witness the device of the present application was devised as an improvement over the device of the Price et al. patent No. 1,842,945 (61).

In that device the tubes open into headers through which the liquid flows from one part of the pipe to another whereas in the present device the pipes are connected outside the end walls of the shell.

The Examiner cited the Wilson patent No. 1,737,347 (55) as showing similar means for connecting passages through a metal block forming a heat exchanger in order to form two complete circulating systems. These connections may be as shown U-shaped pipes on the outside of the blocks.

It is submitted that if it were desirable to connect the pipes of the Price et al. patent instead of using a header, it was not invention to do so in the manner shown in the Wilson patent.

The third limitation refers to the structure shown in Figure 5 of the application. The tube sheets 11 and 13 are held in substantially spaced relation by the longitudinal members 18. The connection of the member 18 to the member 14 as shown in Figure 5 permits a certain amount of longitudinal play.

Just this sort of a connection between the corresponding parts is shown in the Brown patent 1,856,618 (67) at the lower left hand corner of Figure 1 and described in lines 116 to 125 of page 3 of the specification (71). It is submitted that it was not invention, in view of the Brown patent, to so fasten the tie members 18 to the tube sheet.

There is no discussion, in appellant's brief, of the remaining claims, but a general reference thereto is found in the last paragraph of page 21 and the first two paragraphs of page 22 of that brief.

There appellant argues against the citing of additional patents to show various details specified in certain of the claims and with reference to claim 8, says:

> Against claim 8 the Patent Office adds to the Price & Ris, Wilson, Brown and Wright com-

> bination forming the basis of its rejection of claim 3, the baffle structure of the Jones patent and the tube bundle support of Sieder.

However, appellant nowhere argues that the inclusion in applicant's device of the baffle structure of the Jones patent, or the tube bundle support of the Sieder patent was an act of invention. It is only contended that it was not proper to cite so many patents.

It should be noted that this is not a case where various old elements have been brought into a new combination with the various elements coacting. For, e. g., there is no coaction between the baffle structure and the tube bundle support or between these two and the means for holding the tube bundle unit in the shell or between all of these and the track on which the tube bundle is moved. Each takes its own part unaffected by the other.

Both the Examiner and the Board of Appeals ruled that the claims involved nothing more than a mere bringing together, in a single structure, of various features which are old in the art, and that was not invention. The Court found as a fact (Finding 10, page 13 of appendix) that such a bringing together of these various old features into a single structure was not invention.

It may well be that the device of the application is much better adapted for the use for which it was intended than the device of the prior patent of Price and Ris, but that does not establish that the claims define invention or that appellant is entitled to a patent containing such claims (See *Cuno Engineering*

Corp. v. *The Automatic Devices Corp.,* 314 U. S. 84, 1942 C. D. 723, and cases therein cited).

In *Morrison* v. *Coe,* 74 App. D. C. 335, 122 F (2d) 793, 1941 C. D. 75, in which was involved an application for patent on an automobile window assembly, this Court said:

> The claim of invention, therefore, boils down to this—turning the flange and fastening it on the inside instead of on the outside and combining it with the already established decorative feature, the garnish moulding. This, while useful and successful, and while meeting the new needs of automobile construction, certainly did not require inventive genius. A skilled mechanic, familiar with Edwards and *the rest of the automobile art,* made an adaptation thereof which was commercially successful, but which does not call for the privilege of a monopoly. [Emphasis added.]

The Court of Customs and Patent Appeals in *In re Welter,* 28 C. C. P. A. 1160, 120 F. (2d) 353, 1941 C. D. 544, with reference to certain claims for a check signing machine said:

> The claims at bar are structure claims, and the structure must be looked to in determining whether or not invention rested in its production. We are in agreement with the views expressed by the tribunals below that combining the features in the old art, together with such modifications as appellant may have made in the individual features, required the exercise of nothing more than mechanical skill.

Lastly attention is called to the decision of the Circuit Court of Appeals of the Sixth Circuit in

Sieberling Rubber Co. v. *I. T. S. Co.,* 134 F. (2d) 871. In this decision, which was written by Judge Simons who has had long experience in considering patent cases, both as a District Judge and on the Court of Appeals, it is stated that there was but a single issue viz. that of invention over the prior art. Many patents were cited as showing what the state of the art was, and the conclusion reached that invention was lacking.

CONCLUSION

In conclusion it is submitted that the involved claims define no invention and that the judgment of the lower court dismissing the complaint should be affirmed.

Respectfully submitted.

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